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GILA RIVER BASIN NEW RIVER AND PHOENIX CITY STREAMS
ARIZONA(U) ARMY ENGINEER DISTRICT LOS ANGELES CA
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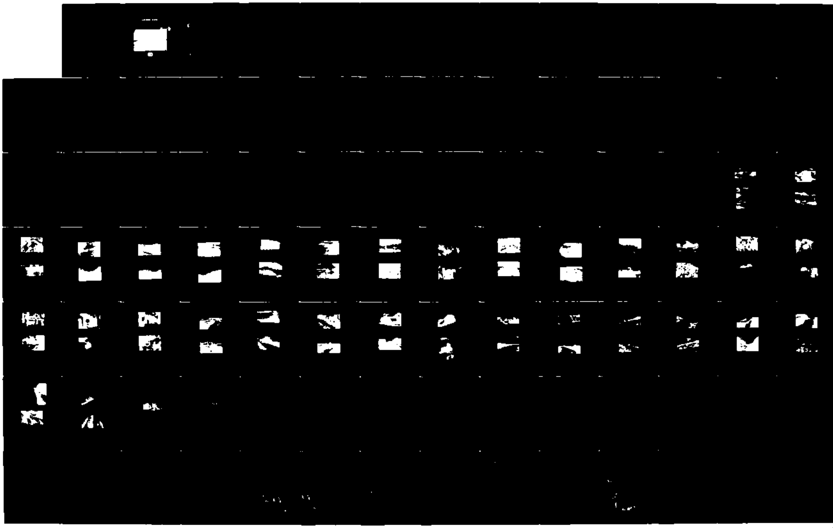

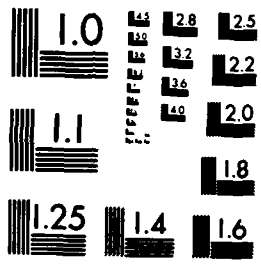

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GILA RIVER BASIN
NEW RIVER AND PHOENIX
CITY STREAMS, ARIZONA

ADOBE DAM

EMBANKMENT CRITERIA AND PERFORMANCE REPORT

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
LOS ANGELES

JUNE 19[illegible]

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The report summerizes embankment features, design data, construction control data, and record test results. Significant construction modifications and changes, construction equipment, construction procedures, and notes are presented, Also, evaluations of design assumptions with as-built field and Laboratory test results are included.

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ADOBE DAM
GILA RIVER BASIN, NEW RIVER
AND PHOENIX CITY STREAMS

EMBANKMENT CRITERIA
AND
PERFORMANCE REPORT

U.S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

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PERTINENT DATA

ADOBE DAM

Reservoir		
Drainage area	sq mi	89.6
Dam (rolled earthfill)		
Crest elevation	ft msl	1,403.0*
Maximum height above streambed	ft	63
Crest length	ft	11,245
Freeboard	ft	5.5
Spillway		
Crest elevation	ft msl	1,377.8
Crest length	ft	36
Elevation of maximum water surface	ft msl	1,397.5
Outlet works		
Size of conduit	ft	5.9W x 8.85H
Length of conduit	ft	289.5
Intake elevation	ft msl	1,338.0
Dike		
Crest elevation	ft msl	1,400.5
Crest length	ft	1,635
Maximum height above existing ground	ft	6
Reservoir area at spillway crest	acre	1,320
Capacity (gross) at spillway crest	acre-ft	18,350
Storage allocation below spillway crest		
Flood control (net)	acre-ft	15,650
Sedimentation (100-year storage)	acre-ft	2,700
Standard project flood		
Total volume	acre-ft	17,000
Peak inflow	cfs	66,000
Peak outflow	cfs	1,890
Drawdown time	hr	229
Maximum probable flood		
Total volume	acre-ft	61,000
Peak inflow	cfs	119,000
Peak outflow	cfs	12,000
Drawdown time	hr	122

I. PURPOSE AND SCOPE

1.01 The report was authorized and prepared in accordance with ER 1110-2-1901, "Embankment Criteria and Performance Report," dated 31 December 1981. The report presents significant data on the design and construction of the embankment. The data can be used to provide information for engineers unfamiliar with the project, re-evaluation of the embankment in the future if required, periodic inspection reports, and background data for design and construction of similar projects.

1.02 The report summarizes embankment features, design data, construction control data, and record test results. Significant construction modifications and changes, construction equipment, construction procedures, and notes are presented. Also, evaluations of design assumption with as-built field and laboratory test results are included.

II. REFERENCES

2.01 "New River and Phoenix City, Streams, Arizona, Adobe Dam, Design Memorandum No. 3, General Design Memorandum - Phase II, Project Design - Part 2," dated April 1979

2.02 Contract drawings "Gila River Basin, New River Phoenix City Streams, Arizona, Adobe Dam, Maricopa County, Arizona," dated August 1980.

2.03 Specification No. DACW09-80-B-0035 "Adobe Dam, Maricopa County, Arizona, Gila River Basin, New River and Phoenix City Streams," August 1980.

2.04 "Adobe Dam Foundation Report," Gila River Basin, Arizona, dated October 1982.

2.05 "Adobe Dam Verification and Demonstration Fills, Core and Random Materials," U.S. Army Engineer District, Los Angeles, June 1981.

III. GENERAL

AUTHORITY

3.01 Adobe Dam was authorized by the Flood Control Act of 1965, Public Law 89-298, 89th Congress.

PROJECT PURPOSE

3.02 Adobe Dam is a part of the New River Phoenix City Streams, Arizona Flood Control Project. The dam functions as a detention basin to provide flood control along Skunk Creek. The detention basin reduces the standard project flood peak of 66,000 cfs to an outflow of 1,890 cfs.

PROJECT LOCATION

3.03 Adobe Dam is located on Skunk Creek in Maricopa County, Arizona, approximately 16 miles north of Phoenix and 1.8 miles west of the I-17 Black Canyon Highway, see plate 1.

PROJECT DESCRIPTION

3.04 The project consists of a zoned earthfill main embankment, random earthfill dike, a detached spillway in rock, and ungated outlet structure. See plate 2 for general project plan. The main embankment is a maximum height of 63 feet above the streambed and is 11,245 feet long. The dike is a maximum height of 6 feet above existing ground surface and is 1,770 feet in length. The spillway is located in a saddle approximately 2,000 feet west of the west abutment. The spillway is 1,311 feet in length with a 36-foot wide invert and was excavated to a maximum depth of approximately 91 feet in rock. The side slopes are 2V:1H and 12-foot wide with benches placed at 30-foot vertical increments. The outlet works consist of an ungated trash racked inlet with invert elevation at 1338.0, a 5-foot-11-inch wide by 8-foot-10-inch high rectangular concrete conduit and energy dissipator.

CONTRACTOR

3.05 The contract DACW09-80-C-0121 for the construction of the dam and appurtenant structures was awarded to M. M. Sundt Construction Company of Tucson, Arizona in October 1980 for $8,388,025.00. Subcontractors used by M. M. Sundt to perform work relative to the construction of the embankment were as follows:

a. W. G. Jaques Co., Des Moines, Iowa - drilling and grouting subcontractor.

b. D. C. Speer Construction Co., Phoenix, Arizona - rock crushing.

c. Engineers Testing Laboratories, Inc. (ETL), Phoenix, Arizona - materials testing.

CONSTRUCTION AND DESIGN STAFF

3.06 Key Corps of Engineers personnel involved in the design and construction of Adobe Dam are listed below:

a. Engineering Division

Project Design Manager	Nick Romanzov
Project Design Leader	Vance Carson
Project Geologist	Dave Lukesh
Embankment Design	Tak Yamashita
Hydraulic Design	Ken Warner

b. Construction Division

Project Engineer	Terry Buckley
Project Officer	Capt. Paul Dunn
Embankment Engineer	Paul Ching
Office Engineer	Dan Moore
Field Superintendent	Joe Salinez
Laboratory Chief	Dewayne Godsell

The project office staff in addition to the above mentioned Construction Division personnel consisted of six inspectors and a field laboratory staff of seven civilian and military personnel.

IV. TOPOGRAPHY AND GEOLOGY

REGIONAL TOPOGRAPHY

4.01 The site lies in the northern portion of Deer Valley, a part of the Salt River Valley. Deer Valley is an undissected plain which slopes upward from the Arizona Canal to the Hedgepeth Hills on the north. The hard rock slopes of the Phoenix Mountains and Union Hills form the eastern border of Deer Valley, and the New River limits the valley on the west. Skunk Creek, the major tributary of the New River, rises in the New River Mountains about 35 miles north of Phoenix and flows generally 30 miles southward through the site to its confluence with the New River. The Skunk Creek drainage area is approximately 110 square miles. The gradient in the vicinity of the proposed dam is approximately 40 feet per mile.

REGIONAL GEOLOGY

4.02 The rock types existing in the mountainous areas within the project area are very similar. The basement complex consists predominantly of Precambrian schistose and massive metaigneous rocks with lesser amounts of gneiss and quartzite. These rocks outcrop near Thunderbird Park approximately 2.75 miles to the north-northwest, and also at Cave Buttes Dam to the east. The trend of foliation in the schistose rock formations is in a northwest direction, and generally is steeply dipping. Igneous rocks in the area consist of granite, rhyolite, andesite, dacite, vesicular basalt flows, tuff and tuffaceous agglomerate. Lava flows of Tertiary to Quaternary age cover a considerable area along the northern margin of the valley, and also cap a few small isolated hills which rise out of the flat valley floor. Older Quaternary sediments are found on the slopes of some of the hills and form several predominant ridges on the east side of Deer Valley. The most extensive Quaternary deposits in the area are the unconsolidated older alluvial materials which consist of gravel, sand, silt, and clay containing varying amounts of caliche. These materials form the flat valley floor and extend to undetermined depths below the surface of the valley. Recent alluvium consisting of unconsolidated silt, sand and gravel fill the channels of the main stream courses and tributaries associated with flood plain washes. Bedrock, similar to that of the nearby hills and mountains, underlie the alluvial deposits at great depths.

GEOLOGIC HISTORY

4.03 During the late Miocene time subsidence, block-faulting and erosion occurred breaking up the region with its existing pre-Cambrian and younger rocks. This gave the area a typical basin-and-range structure of mountain-forming horsts separated by valleys underlain by grabens or half-grabens.

4.04 Sediments were deposited in these troughs or grabens during late Cenozoic time. These sediments consist of clastics and lesser amounts of interbedded volcanic rocks, and in some valleys, thick intervals of evaporites. All are continental deposits. Estimates of thickness of these sediments amounts to 3,000 feet in the Deer Valley area where Adobe damsite is located.

4.05 Many of the older volcanics are from the mid-Tertiary (late Oligeocene and early Miocene) orogency, which produced great quantities of rhyolite to andesitic tuffs, breccias, and flows. Fanglomerate and lacustrine deposits alternate with these volcanics. Overlying these volcanics and other deposits are fanglomerates (containing volcanic detritus) as well as beds of water-laid tuffs and other sediments intercalated with and overlain by basaltic lava flows. These are believed to be middle to late Miocene. The Adobe area is likely devoid of evaporites, but evidence of surface lacustrine deposits exists. The top most basalts are possibly as young as 6 million years or less, making them Pliocene in age.

FAULTING

4.06 Block faulting and tilting had an important effect upon the topographic forms in the Deer Valley area. This is typical basin and range topography. These structural movements apparently reached a maximum during the Miocene period. Although of considerable magnitude, the faulting and tilting has been gradual, and the tilted blocks are not greatly broken up, and the lineaments remain. The strike of the major movements conforms with the general northwest structural trend of the region, but there are numerous northeast trending cross faults. No evidence of folding was observed in the area.

4.07 The Verde Fault system to the north, see plate 3, consists of a series of unconnected faults which, when combined, would be approximately forty-five miles long. The Verde fault system has a longest segment of 24 miles, which relates to a maximum credible earthquake of magnitude 6.5 to 7.4. This results in an expected maximum bedrock acceleration at Adobe Dam of 0.12g. The largest earthquake ever recorded on this fault was a magnitude 5.2 which would produce virtually no ground acceleration at Adobe Dam.

4.08 One branch of the Verde system, about 60 miles from the project site, extends into the Chino Basin east-northeast of Prescott. A recent earthquake (1976) with a magnitude of 5.2 was centered in this area but evidence of any fault movement was not recorded.

4.09 The most significant fault in the state is the Main Street Fault. It trends to the north and is 110 miles long. This fault, which is not considered to be active, is located approximately 150 miles northwest of the project site. The last movement on the Main Street Fault was probably over fifty thousand years ago.

4.10 The third largest fault system is located near Globe, Arizona, approximately 95 miles east-northeast of the project site. This system is approximately 42 miles long and is not considered active.

SITE GEOLOGY

4.11 The proposed project is located approximately 16 miles northwest of Phoenix, and about 2 miles west of the Black Canyon Highway. The damsite spans Skunk Creek between Adobe Mountain and the Hedgpeth Hills. The hills are capped with Quaternary lava flows which vary in thickness from a thin veneer to many feet. The flows are composed of dark-gray vesicular olivine basalt, andesite, flow breccia, scoriaceous basalt and tuffaceous agglomerate. Underlying this Quaternary volcanic flow are Tertiary volcanics composed of basalt, ryolite, andesite, latite, and dacite. The flat valley floor consists of poorly to well-cemented Quaternary gravels, sands, silts and clays that extend to great depths below the ground surface. This Quaternary alluvium has been estimated to extend approximately 3,000 feet below the present ground surface. The recent alluvium is usually confined to the channels of the creeks and consists of loose sands and gravels. See plate 4 for general site geology.

V. FOUNDATION

INVESTIGATIONS

5.01 Foundation investigations of the right abutment, outlet works and streambed consisted of geologic mapping and reconnaissance, deep and shallow seismic refraction surveys, down hole electrical and gamma ray surveys, diamond core drilling, bucket type power auger drilling, trenching with a dozer and backhoe, in-situ density testing, and percolation testing. Detailed discussions of the foundation investigations are presented in the references listed in paragraph 2.01 and 2.04.

Dam Foundation

5.02 The investigation of the streambed portion of the dam foundation consisted of drilling 10 borings with a bucket type power auger to depths from 25 to 66 feet and excavating 13 trenches with a backhoe and dozer to depths from 12 to 26 feet. The location of the borings and trenches are shown on plate 5. The soil logs of the borings and trenches are summarized on plates 6, 7 and 8.

5.03 Thirty-three in-situ density tests were conducted in the near surface embankment foundation materials by the sand displacement method. An additional seven densities were obtained from undisturbed samples by the bulk density method. The results of density tests in the foundation are shown on plate 12.

5.04 Percolation tests were conducted in test holes to obtain large scale field data to determine a representative coefficient of permeability of the foundation material. The average coefficient of permeability TH76-24 is approximately 6 feet per day.

5.05 Geophysical investigations consisting of 8 seismic refractive lines varying in length from 290 to 880 feet were conducted in the streambed.

West Abutment and Outlet Works

5.06 Investigations of the west abutment and outlet works foundation consisted of drilling 15 diamond core holes to depths from 28 to 81.2 feet and excavating one test trench with a D8-H dozer to a depth of 9 feet. The locations of core holes and trench are shown on plate 9. The logs of the core holes and test trench are shown on plate 10.

FOUNDATION TREATMENT

Streambed Materials

5.07 The foundation materials consist of non-homogeneous alluvium extending to a depth of at least 1,250 feet. Typically the foundation materials consist of moderately to highly cemented sands-silty sands and gravels-silty gravels interspersed with lenses and layers of silty and clayey sands with an occasional layer of sandy clay. A change in materials occurs at a depth of approximately 5 feet. The materials in the upper 5 feet consist of fine grained soils consisting predominantly of sandy silts and clays to silty and clayey sand. Consolidation tests indicated the near surface fine grained soil were susceptible to collapsing when saturated to an amount ranging from 5 to 13 percent of the layer thickness. The gradational range and plasticity chart of the upper 5 feet of materials are shown on figures 1 and 6, respectively.

5.08 The foundation materials below the embankment consist principally of coarse grained materials classifying predominantly as silty and clayey gravelly sands with small lenses and layers of silty and clayey sands, sandy silts, clays, cobbles and boulders. Cemented areas with varying degrees of cementation occur throughout the foundation area. The range of gradation and the plasticity chart for foundation materials below the embankment are shown on figures 2 through 5 and 7.

5.09 The foundation treatment from the right abutment to Sta. 85+90 consisted of prewetting with sprinklers and excavating the near surface fine grained soils down to coarse grained soils. The extent of foundation excavation is shown on plates 22 to 24. The materials were excavated with two D9-H dozers and 651B scrapers as shown on photo 4. A view of completed foundation excavation in an area east of 35th Avenue is shown on photo 5. After foundation excavation was completed, Corps personnel inspected the foundation area to insure embankment material compatibility with foundation materials. Foundation materials not compatible with core materials were removed from the foundation grade at Sta. 19 to 21, 31 + 50, and 35 to 39. Materials not compatible with gravel drain material were removed from Sta. 54 to 58.

5.10 After completion of the foundation excavation an exploration trench was excavated to a depth of approximately 10 feet as shown on plates 13 to 21 and 23. The exploration trench was excavated with two D9-H dozers and 651B scrapers as shown on photo 6. Typical materials encountered consisted of silty gravelly sands with cobbles are shown in photos 8 and 11.

5.11 After inspection and approval of the foundation grade, exploration trench bottom and sidewalls, the area approved was scarified to a depth of 6 inches. The moisture content was then adjusted by adding water, see photo 10, to within the specified range of -2 to +3 percent of optimum. After moisture adjustments the area was compacted with 8 passes of a 50-ton rubber tired roller. The rippers used to scarify the foundation area are shown on photo 7. Typical results of scarifying and rolling of the foundation with a 50-ton rubber tired roller are shown in photos 8 and 9.

5.12 At Sta. 85+90 the embankment is founded above spillway crest elevation and is less than 26 feet in height. The foundation treatment consisted of the same procedure as described for the reach between the west abutment to Sta. 85+90 but without the exploration trench. The completed foundation excavation is shown in photo 5.

Right Abutment

5.13 The right (west) abutment of the dam is located on the east slope of the Hedgepeth Hills. The abutment consists of volcanics composed of basalt and andesite blocks, infilled with tuffaceous materials in the upper slopes. Agglomerates form the foundation surface in the exploration trench abutment contact.

5.14 The right abutment was in general excavated in three phases. The first phase consisted of stripping the surface materials to depths of 2 feet using a D-9H dozer with rippers, see photo 12. The second phase consisted of drilling, blasting and removal of loosened material with a D-9H dozer to depths ranging from 4 to 12 feet, see photos 13, 14 and 15. The large basalt blocks, up to 4 feet, excavated from the abutment were used as backfill in the upstream toe trench, see photo 16. The third phase was the most important phase and consisted of cleaning the abutment to a suitable foundation. The construction sequence, geology, stripping, drilling and blasting are discussed in more detail in the report referenced in paragraph 2.04.

5.15 After completion of stripping, the abutment area downstream of the core was drilled, blasted, and cleared of loosened rock with a D-9H dozer, see photo 15. After removal of the blast loosened material the excavated surface material consisted of silty sand, sandy silt and loose rock, see photos 15 and 17. To determine if a suitable abutment foundation had been reached, 22 exploratory drill holes with a rotary percussion air track drill rig were drilled to qualitatively evaluate the underlying abutment foundation materials. The evaluation was based upon the rate of drill bit penetration, which is a measure of the relative hardness of the underlying materials. Results indicated the materials would not significantly change with depth and the underlying materials would consist of hard basalt blocks with softer infilling.

5.16 To evaluate and inspect the abutment foundation surface, a 40x40 feet area was excavated and cleaned with a backhoe, hand labor and air cleaning, see photo 18. A portion of the cleaned area being inspected is shown on photos 19 and 20. Note the large blocks of basalt, the irregularity of the surface and the infilling between the rock blocks.

5.17 The abutment foundation as exposed in the 40x40 feet cleared area was determined to be suitable with adequate surface treatment. Typically suitable foundation consists of an irregular surface of large basaltic blocks, with fractures and cavities filled with a tuffaceous material, see photos 20 and 21. The abutment foundation, as exposed, was not entirely as expected based upon design core hole data. The infilled fractures were larger and more numerous than anticipated during design. For detailed discussion see reference listed in paragraph 2.04. To determine the engineering properties of the infilling material, detailed laboratory tests were conducted on undisturbed chunk samples. The detailed laboratory tests were conducted by Engineering Testing Laboratories Inc., Phoenix, Arizona and by the South Pacific Division Laboratory at Sausalito, California. The detailed laboratory tests consisted of gradation, in-place density, specific gravity, consolidation, dispersive soil test, soluble salts test, and permeability test.

5.18 The laboratory tests indicate the tuffaceous infilling material is relatively dense, incompressible, impervious and non soluable. The materials classify as a silty sand and have a gradation range shown on plate 31. The consolidation and permeability test results are shown on plate 31. The permeability of the infilled materials would be less than 1.0 feet per day (fpd).

5.19 After inspection of the 40x40 foot area the remainder of the abutment was drilled and blasted. Loosened materials were removed with a D-9H dozer. The remaining loosened materials, covering the abutment, not removed by the D-9H dozer, were removed with backhoes, hand labor and air blasting. A view of the cleaned abutment is shown on photo 22. As-built foundation excavation is shown on plate 22.

5.20 Treatment of the abutment foundation, after cleaning, consisted of subsurface grouting and final surface preparation. Subsurface treatment, consisting of a single line grout curtain along the core contact centerline, was placed by subcontractor W. G. Jaques Company of Des Moines, Iowa from August to November 1981. The right abutment foundation grouting plan and profile are shown on plate 25.

5.21 Final surface preparation of the abutment foundation, beneath the random and gravel, consisted of removing loose materials by hand and minimal air blasting. Surface preparation, beneath the core materials, consisted of cleaning joints and fractures of loose infilling, intensive air cleaning, slurry grouting open joints and fractures, and placement of dental concrete. The infilled joints and cracks were cleaned using a rock pick and air blasting to remove loose materials. Slurry grouting consisted of placing grout mix, a 1:1 ratio of sand to cement, into cleaned and wetted cracks, joints, and voids too small for placement of dental concrete.

5.22 Dental concrete was placed on the abutment surface to receive core materials, see photos 23 and 24. Dental concrete was used in lieu of hand compacted core materials for the following reasons:

a. Due to the very irregular foundation surface, dental concrete was placed in the depressions to form a uniform surface on which core materials could be equipment compacted.

b. Potential seepage entrance points in the abutment foundation would be sealed.

c. Core materials would be separated from tuffaceous infilled material by the dental concrete.

The dental concrete consisted of a low slump, 3/4-inch aggregate, 1000 psi concrete. Cleaned surfaces were wetted with water, prior to placement of dental concrete. The dental concrete was placed with a crane hoisted bucket. To preclude feather edges, concrete was placed at a minimum thickness of 6 inches. To consolidate and insure bonding the concrete was vibrated in place with special emphasis on the foundation surface-concrete contact. After vibration, the concrete surface was screen tamped, see photos 23 and 24.

Left Abutment

5.23 The left abutment of the dam is founded on the west slope of Adobe Mountain. The abutment is located basically in the freeboard elevations from 1395 to 1403 feet. Foundation treatment consisted of removal of talus and residual soil to a suitable foundation. The excavation of the abutment was an extension of the embankment foundation excavation. The completed abutment excavation is shown on photo 25. A D-9H dozer, backhoe and front end loader were used to excavate the abutment.

VI. EMBANKMENT

FEATURES

6.01 The dam is a compacted, zoned earthfill structure composed of random shells, an upstream blanket tied into a central core and a downstream gravel vertical drain tied into the downstream horizontal gravel drain blanket. The upstream slope is protected by type I (18-inch thick) and type II (15-inch thick) stone. The downstream slopes are covered by 6 inches of type III stone. The embankment plan, profile and cross sections are presented on plates 13 to 24.

6.02 The embankment was constructed in four stages. Stage 1 was diversion and control, which consisted of construction of the upstream slope of the dam, from Sta. 21+ to 70+32 to a height of approximately 10 feet. Stage 2 consisted of constructing the embankment to El. 1378 at Sta. 21+ to crest elevation at Sta. 82+80 and to crest elevation from Sta. 82+80 to 121+80. Stage 3 embankment construction consisted of the closure section located at Sta. 21+00 to the right abutment to El 1378. Stage 4 was the completion of the embankment.

MATERIALS

6.03 Core materials meeting specification requirements were obtained by blending the near surface materials of Borrow Area 1 to a depth of approximately 5 feet and from materials obtained from foundation excavation. See plate 11 for location of borrow area, and plate 26 for gradation of as-placed core materials.

6.04 Random materials meeting specification requirements were obtained from Borrow Area 2 and from the coarse materials located beneath the core materials of Borrow Area 1. See plate 11 for borrow location, and plate 29 for gradation of as-placed random material.

6.05 Gravel drain materials were obtained from two sources. The gravel drain materials in the embankment east of 35th Avenue were obtained by processing waste material from the ACI gravel pit, located 4.5 miles east of the dam. The processing consisted of dry sieving the waste materials. Gradations of the as-placed gravel drain materials are shown on figure 8.

6.06 The gravel drain materials, in the embankment west of 35th Avenue, were obtained by processing rock excavated from the spillway. The processing consisted of crushing and grading the rock, see photo 27. Gradations of the as-placed gravel drain materials are shown on figure 8.

6.07 The filter material consisted of a washed fine concrete aggregate obtained from the ACI gravel pit, see figure 9 for as-placed gradations.

6.08 Type I and II stone were obtained from stone waste piles located in the ACI gravel pit see photos 28 and 29. The stone waste piles consisted of stones larger than 6 inches. Type I stone was obtained by processing the stone. Processing consisted of grading the stone with a grizzly, see photo 30, to obtain a larger stone size. The stone in the waste pile was used without processing as Type II stone. Gradations of the Type I and Type II stone are shown in Table 1.

TABLE 1
GRADATION REQUIREMENTS
Type I Stone

Weight of Pieces	Percent Smaller by Weight
500 pounds	100
250 pounds	50 to 75
130 pounds	30 to 50
20 pounds	0 to 10
15 pounds	0

Type II Stone

Weight of Pieces	Percent Smaller by Weight
200 pounds	100
100 pounds	50 to 75
50 pounds	35 to 50
10 pounds	0 to 10
7 pounds	0

Type III Stone and Bedding Layer

Sieve Size	Percent by Weight Passing
6 inches	100
3 inches	40 to 75
3/4 inches	20 to 40
Number 4	0 to 10

6.09 Type III stone and bedding were obtained from processing the rock excavated from the spillway. Processing consisted of crushing and grading the excavated rock, see photo 27.

6.10 Topsoil fill was obtained from the near surface soil from Borrow Area 1.

VII. EMBANKMENT QUALITY CONTROL, ASSURANCE, AND TESTING

GENERAL

7.01 Contractor quality control and Government quality assurance testing of the embankment fill was performed to ensure quality work and to check conformance of the placed materials with contract specifications. These activities involved the combined efforts of the Contractor's Quality Control personnel, and the Corps of Engineers inspectors and laboratory personnel. The results of these activities assured that materials were placed within specified gradations and moisture contents, and that design densities were being obtained by the specified procedural compaction methods. Corps of Engineers personnel periodically obtained both disturbed and undisturbed record samples to establish classification, density, shear strength, consolidation and permeabilities of the as-built embankment materials in order to verify that design assumptions were met.

CONTRACTOR QUALITY CONTROL

7.02 Contract provisions required the contractor to insure embankment quality. Accordingly, a Quality Control Program was established by the contractor. The following items, pertaining to the embankment, were performed by the contractor:

a. Reviewed contract requirements, checked worksite for readiness and that lines and grades had been established.

b. Checked for compliance with Contract Specifications and that required testing procedures were being followed.

(1) Continuously monitored embankment fill operation.
(2) Established necessary moisture-density relationships for Contractor information and use.
(3) Performed field density tests to determine degree of compaction per ASTM D698, D1557 and D1556.
(4) Performed gradation testing on embankment materials per ASTM C136.
(5) Performed Quality tests for Stone Protection as follows: ASTM C-88, C-127, C-136, C-131, AND C-535.
(6) Supervised the Installation of Specified Instrumentation.
(7) Prepared daily quality control reports which listed activities, described quality control surveillance activities and instruction, summarized material quantities and listed all test results.

CORPS OF ENGINEERS INSPECTION AND TESTING

7.03 Several inspectors provided continuous monitoring of embankment fill operations. In addition, Corps of Engineers on site Soils Laboratory personnel performed quality assurance tests consisting of field density, placement moisture contents, gradations, compaction, and vibratory maximum-minimum density tests.

Field Density Tests

7.04 In place density tests on core material were performed in accordance with ASTM Standard D1556, "Density of Soil in Place by the Sand-Cone Method", see photo 31. The upper 6 to 18 inches of fill were removed from the area to be tested and a smooth, level surface prepared. Density test were performed on random zone material using a large-scale water displacement method. This method utilized a four-foot diameter steel ring. The procedure involved digging approximately a 2 1/2-foot hole, weighing the material excavated, and metering the water to find the volume of the sample obtained, see photos 32 to 36. Densities of random backfill around the conduit and behind the energy dissipator walls were conducted by the Sand-Cone method because restrictions on space prevented the use of the large density equipment.

Moisture Content Tests

7.05 A laboratory moisture determination was made for each field density test. Visual assessment and microwave oven results were used for rapid determination of moisture content and checked with standard oven drying test results.

Gradation Tests

7.06 Gradation tests were performed on material collected for each density test. In addition, numerous gradations were performed on representative samples of the gravel drain, filter, and slope protection materials to verify compliance with specifications.

Moisture Density Tests

7.07 Moisture-density relationships were determined for representative soil types of core materials by ASTM D-698. An equivalent standard compaction test, using a 12-inch diameter mold with 140 blows per each of 3 layers with a 11-1/2-pound rammer falling 24 inches, was used to determine the moisture density curves for representative random embankment materials. A family of compaction curves representative of typical soil types was developed for the random and core materials prior to the start of fill placement.

7.08 During construction a one-point compaction test was performed on samples obtained with each in place density taken. The percent of maximum dry density was then interpolated from the family of compaction curves. For approximately every ten densities, a five-point compaction test was conducted.

Relative Density Tests

7.09 A small number of relative density tests were performed on the gravel drain and filter material in accordance with ASTM Standard D 2049, "Relative Density of Cohesionless Soil". These were performed near the beginning of the placement procedure to insure that the specified procedural placement of these materials was obtaining acceptable densities.

Record Sampling and Testing

7.10 Record samples of the as-built embankment were periodically obtained by Corps of Engineer personnel, see photos 37 and 38. These samples, both disturbed and undisturbed, were obtained at locations predetermined by Engineering Division. The samples were shipped to the SPD Soils Laboratory for record testing in order to determine the material properties of the as-built embankment. The testing program included classification, compaction, triaxial shear, permeability, consolidation and aggregate tests on three gravel drain samples. Three field density determinations were made adjacent to each record sample location.

VIII. CONSTRUCTION PROCEDURES

CORE MATERIALS

8.01 Moisture was introduced into the core materials prior to excavation by prewetting the borrow area.with a sprinkler system. The borrow area was ripped with a D-9H dozer and moisture was added in areas where the moisture content was on the dry side of specification requirements. Core materials were excavated with Cat 651B scrapers pushed by two D-9H dozers. The materials were spread on grade in 12-inch lifts with a motor grader. Oversize stone were windrowed out of the fill during spreading operations. Water was added when required with a 10,000 gallon water pull prior to compaction or prior to placement of the next lift. Compaction was accomplished with 6 passes of a towed, double drum tamping roller, see photo 40, with a 5-foot diameter and 5-foot width drum and a ballasted weight of 20,000 pounds.

8.02 Select core materials consisting of more plastic materials were placed wet of optimum at the abutment core contact on the right abutment. The purpose of placing the select core materials was to insure bonding between the abutment and core materials and to maximize the filling of voids and cracks with core materials. The treated abutment surface was cleaned of loose materials 5 to 8 feet ahead of core placement. The cleaned and treated abutment surface was thoroughly wetted prior to the placement of core materials. The initial lifts were placed in 6 to 12-inch thickness with a Cat 980C front end loader. Compaction was accomplished by 8-wheel coverages of the 980C front end loader with a loaded bucket, see photo 41. Where wheel rolling could not be accomplished hand compaction was used to compact the core materials. Wheel rolling was used to prevent damage to the treated abutment surface by the tamping roller. The compacted surface was scarified by back dragging the bucket teeth prior to placing a new lift. Compaction with a tamping roller was initiated when a sufficient thickness of material covered the abutment.

RANDOM MATERIALS

8.03 Random materials were excavated on a slope with Cat 651B scrapers pushed by two Cat D-9H dozers, to facilitate blending, see photo 26. The compacted surface of the preceding lift was scarified to a depth of 6 inches prior to placement of the next lift, with rippers on the motor grader, see photo 42. The materials were spread in 12-inch lifts by a motor grader or D-8H dozer. Oversize stones were removed during spreading operations by windrowing, see photo 43. From February to May 1981 each lift was compacted by four passes of an Ingersoll Rand SP-60 DD steel drum vibratory roller with 100-inch drum width, 39,200 pound static weight and 83,100 pounds of dynamic force, and from June 1981 to job completion each lift was compacted by four passes of a towed Ferguson Model 230 vibratory roller with a drum diameter of 5'6" and width of 6'6", a static weight of 22,000 pounds and a dynamic force of 68,500 pounds, see photos 44 and 45.

8.04 No special procedures were used in placing and compacting random materials at the right abutment. Nested cobbles at the abutment contact were removed prior to compaction of the lift.

GRAVEL DRAIN

8.05 Gravel drain materials in the downstream horizontal blanket were placed with bottom and end dump trucks. The gravel in the vertical drain was placed with bottom dump trucks, see photos 46 and 47. The gravel was spread in the blanket with a rubber tired dozer, see photo 48. The gravel in the vertical drain was not spread. Compaction of the gravel drain materials was accomplished by the controlled passes of the rubber tired dozer and motor grader to minimize particle crushing.

FILTER MATERIALS

8.06 Filter materials located at the downstream foundation excavation slope and right abutment were placed with a front end rubber tired loader, see photo 49. Compaction of the filter material located on the excavated slope

was accomplished with a rubber tired dozer during compaction of the gravel drain materials. The filter materials on the right abutment were compacted with the controlled movement of the rubber tired front end loader.

TYPE III STONE AND BEDDING

8.07 Type III stone and bedding were obtained from crushing and grading selected material obtained from the spillway excavation. The crushed and graded material were stockpiled near the spillway prior to placement. The type III stone and bedding east of 35th Avenue were placed with a Cat 977 front end loader and 70-ton crane with a drag bucket, see photos 50 and 51. The bedding and type III stone west of 35th Avenue were placed with a 150-ton Link Belt crane with a BG blade, see photos 52 and 53.

TYPE I AND II STONE

8.08 Type I stone was obtained by processing waste stone piles from the ACI gravel pit. Processing to obtain a coarser gradation consisted of grading the waste stone over a grizzly, see photo 30, to obtain Type I stone. Type II stone was obtained by using stone from the waste pile. Type I and II stone were placed on the slope with a BG blade, see photo 54.

SPILLWAY

8.09 Excavation of the spillway is discussed in detail in reference cited in paragraph 2.04. The spillway excavation in general consisted of drilling explosive charge holes, blasting and excavating. Excavation of the loosened rock was accomplished with 651B scrapers pushed by two D-9H dozers, see photo 56. The excavated materials were placed upstream of the spillway in the disposal area, with basaltic materials selectively stockpiled for the crusher. The spillway walls were trimmed with a slope board attached to a D-9H dozer, see figures 57 and 58. The slope trimming was conducted to remove overhangs, loose material and dress up the slopes.

OUTLET

8.10 Excavation and cleaning of the outlet is discussed in detail in reference cited in paragraph 2.04. The following is a brief description of the construction procedures at the outlet. The methods and procedures used to excavate and clean the outlet trench were the same as was used for the abutment, see photos 59 and 60. After excavation and cleaning, the trench invert was located approximately 2 feet below the "B" line and the trench walls were over excavated by approximately 2 to 3 feet. The overexcavation was primarily due to the blocky nature of the rock, see photo 60. The blocky nature of the rock also caused the final invert surface to be highly irregular, see photo 60. The contract specifications require overexcavated areas to be backfilled with concrete. Concrete was placed to "B" line elevations beneath the conduit section and to "A" line elevations beneath the intake and energy dissipator sections, see photo 61.

8.11 A concrete plug, see photo 62, was constructed on both sides of the outlet conduit to the top of rock beneath the core zone to preclude seepage paths along the outlet trench and to minimize differential settlements. A low slump, 3/4 inch aggregate mix was placed with a concrete bucket and crane. The low slump allowed the concrete to be placed on the 1:1 slope without forms. The concrete was vibrated with emphasis on the outlet conduit and rock face contact zone.

TOPSOIL FILL

8.12 Topsoil fill was placed over portions of the type III stone on the downstream slope. The purpose of the topsoil fill was to break up the visual impact of the type III stone erosion protection. The topsoil fill was placed on the downstream slope east of 35th Avenue with a G-1000 Gradall, see photo 63. The 150-ton Link Belt crane was used to place topsoil fill west of 35th Avenue. The fill was placed in a thicker layer than envisioned during design.

IX MATERIAL PROPERTIES

GENERAL

9.01 As required by ER 1110-2-1925, "Field Control Data for Earth and Rockfill Dams," field control results were summarized by the Resident Engineer staff and periodically transmitted, through the Geotechnical Branch, to the South Pacific Division during active construction periods. Through the completion of embankment fill operations, nine field control reports had been forwarded. These reports, along with the Report of Soil Tests on the Adobe Dam record samples, yielded the following results.

CORE MATERIAL

Field Control Results

9.02 A final statistical analysis of field control test results on the core material are summarized graphically on Plate 26. The monthly field control and placement data are shown on Plate 27. A plan and profile of the field control test locations is shown on plate 32.

a. Moisture-Compaction Trends. Specifications required the placement moisture content of the core material to be within the range of 2 percent below to 3 percent above the optimum moisture content. Design required the material to be compacted to not less than 95 percent of maximum dry density as determined by test method ASTM D-698. The field control test results indicate that core fill was generally placed slightly wet of optimum with a mean of 0.6 percent above optimum moisture content. The plot of placement moisture content for the core material indicates slightly drier placement during the spring and early summer. An upward trend in placement moisture is observed during the autumn months through the end of the project. This is attributed in part to the cooler temperatures and in part to the extensive testing of the abutment contact material where wet-of-optimum core was placed. Field density tests indicate core materials were compacted to an average of 100.1 percent of maximum dry density.

b. Gradation. Specification required the core material to have a minimum of 20 percent by weight passing the No. 200 sieve. Results of field control tests indicate that less than 1 percent of the tests, had less than 20 percent passing the No. 200 sieve while 10 percent of the tests had more than 64 percent passing the No. 200 sieve. Results indicate the core material was finer grained than anticipated during design. The fines content anticipated during design had a mean of 40 percent by weight passing the No. 200 sieve while the field control test results had an average of 50 percent by weight passing the No. 200 sieve.

Record Test Results

9.03 Test results performed by the SPD Laboratory on record samples of the core material are summarized on plate 28.

a. Permeability. Permeabilities of undisturbed core material record sample were determined in both the horizontal and vertical directions. The results are shown on plate 28. The horizontal permeabilities averaged 6.4×10^{-3} feet per day (fpd) and the vertical permeabilities averaged 4.0×10^{-3} fpd. Both horizontal and vertical permeabilities fell within the design permeability range of 1.0×10^{-3} to 1.0×10^{-1} fpd.

b. Shear Strength. Core material shear strengths were determined for undisturbed record samples using triaxial compression tests in accordance with the procedures described in EM 1110-2-1906, "Laboratory Soil Testing," 30 November 1970. Both total and effective strengths were determined under unconsolidated undrained (Q-type) and consolidated undrained conditions with pore pressures measured and recorded (R-type). In general, the as-built strengths were somewhat higher than the assumed design strengths. The selected as-built "Q" strength had an angle of internal friction of 32 degrees and cohesion of zero. This was higher than the design "Q" strength of 30 degrees and cohesion of zero. The selected as-built "R" strength had an angle of internal friction of 18 degrees and a cohesion of 800 psf. This strength was higher than the design angle of internal friction of 14 degrees and cohesion of 600 psf. The selected as-built effective "S" strength had an angle of internal friction of 34 degrees and cohesion of zero. This was the same as the assumed design "S" strength.

c. Consolidation. Consolidation tests were performed on undisturbed record samples obtained from the core zone of the embankment. The results of these tests are shown graphically on plate 28 in terms of void ratio (e) vs. pressure (log P) curves. The record samples as indicated by the test results have consolidation curves similar those used during design. The initial void ratios of the undisturbed record samples varied from 0.345 to 0.865. The sample with the high initial void ratio of 0.865 had a dry density of 91.0 pounds per cubic foot (pcf) and is not representative of the as-built field densities which had a mean value of 113.5 pcf, see field control data.

RANDOM MATERIALS

Field Control Results

9.04 A final statistical analysis of field control test results on the random material are summarized graphically on plate 29. The monthly field control and placement data are shown on plate 30. A plan and profile of the field control test locations are shown on plate 32.

a. Moisture-Compaction Trends. Specifications required the placement moisture content of the random material to be within the range of 3 percent below to 2 percent above optimum moisture content and the material to be compacted to not less than 95 percent of the maximum dry density as determined by a compaction test equivalent to test method ASTM D-698. The field control test results indicate that random fill was generally placed slightly dry of optimum with a mean of 1.3 percent below optimum moisture content. The mean placement moisture content was 7.5 percent. No significant seasonal trends in placement moisture content were observed, however, considerably more water was placed on grade during the dry, hot summer months. Field density tests show the random material was compacted to an average of 102.0 percent of maximum dry density with an average dry density of 135.6 pcf.

b. Gradation. Specifications required the random material to have no more than 20 percent by weight passing the No. 200 sieve. Field control test results indicate that less than 10 percent of the tests had more than 20 percent passing the No. 200 sieve. The average fines content for the random zones of the as-built embankment was 12.0 percent.

Record Test Results

9.05 Test results performed by the SPD Laboratory on remolded record samples of the random material are shown on plate 31.

a. Permeability. Results of the record permeability tests on the random material show that the material had an average value of 12.3 fpd. This is slightly higher than the 0.1 to 10.0 fpd permeability range assumed in design.

b. Shear Strength. Random material shear strengths were determined for remolded record samples using triaxial compression tests. Strengths were determined under consolidated undrained conditions with pore pressures measured and recorded (R-type). The as-built strengths were overall higher than the assumed design strengths. The selected as-built "R" strength had an angle of internal friction of 20 degrees and a cohesion of 2000 psf. The assumed design "R" strength had angle of internal friction of 13 degrees and a cohesion of 1600 psf. The selected as-built effective "S" strength had an angle of internal friction of 37.5 degrees and a cohesion of zero. This was slightly higher than the assumed design angle of internal friction of 37 degrees and cohesion of zero.

GRAVEL DRAIN MATERIAL

Field Control Results

9.06 A final statistical analysis of field control gradation test results on the gravel drain material is summarized on figure 8. The modified specified gradation of the gravel drain material is listed in table 2. The results on figure 8 indicate that 10 percent of the materials were out of the specified gradation requirements on the fine and coarse side.

Record Test Results

9.07 Test results on remolded record test samples of the gravel drain material are shown on plate 31 and summarized in table 3.

TABLE 2

GRAVEL DRAIN MATERIAL
MODIFIED GRADATION

Sieve Size	Percent Passing by Weight
1 1/2 inches	100
3/8 inches	20-100
# 4	0-40
#10	0-7

TABLE 3

GRAVEL DRAIN MATERIAL FROM SPILLWAY
EXCAVATION RECORD TESTS

Tests	Stockpile	Production A	Production B
1. L.A. Rattler % loss	29	24	27
2. Specific Gravity	2.50	2.49	2.47
Absorption, %	3.8	4.0	5.0
3. Soft Particles, %	5.0	8.4	9.5
4. Friable Particles, %	0.5	0.8	0.7
Friable Particles, Sand	-	0.4	0.9
5. Sulphate Soundness, %	19.1	20.0	18.5

a. Permeability. The record test results are shown on plate 31. The results indicate the permeability would range from 2,700 to 32,000 fpd. Four of the five permeabilities were at or higher than the design permeability of 7,000 fpd. The average permeability has a value of 10,160 fpd.

b. Quality Tests. The results of L.A. Rattler, specific gravity, absorption, soft and friable particle and sulphate soundness tests are summarized in table 3. The results meet specification requirements.

FILTER

9.08 Specified gradations and results of field control tests consisting of gradation tests are shown on figure 9. The results indicate filter requirements between the foundation to filter and filter to gravel drain were met.

ABUTMENT INFILL

9.09 After abutment excavation and prior to abutment preparation, undisturbed samples were obtained of the abutment infill material and sent to the SPD and ETL (contractor's laboratory) for testing. Due to the relatively small size of the samples, only dispersion, soluable salts, classification, permeability and consolidation tests were performed. The results are shown on plate 31.

Classification

The abutment infill material classified as a non-plastic, silty sand (SM). The gradation of the infill material is shown on figure 10.

Permeability

9.11 The horizontal permeability of the undisturbed abutment infill material was measured by SPD Laboratory at 0.75 fpd. The permeability falls between the measured permeability of the core and random materials.

Consolidation

9.12 Consolidation tests conducted by SPD and ETL laboratories are shown on plate 31. The results indicate that for the expected embankment loading the infill materials are highly incompressible.

Dispersion and Soluable Salts

9.13 Dispersion and soluable salts tests conducted by ETL indicate the infill materials are nondispersive and contain 0.12 percent soluable salts.

X. EMBANKMENT ANALYSIS

SLOPE STABILITY

10.01 Results of triaxial shear strength tests indicate that the shear strength of the as-constructed embankment materials are higher than the design shear strengths. Therefore, the as-built embankment more than satisfies slope stability requirements. The slope stability of the embankment was not re-analyzed and the results of the original design slope stability analysis are presented on plates 33 and 34. The slope stability safety factors of the as-built embankment slopes exceed the original design safety factors.

SETTLEMENT

10.02 The results of the consolidation tests on record samples of the as-built embankment indicate no significant variation in the e. vs log p curves when compared to the design consolidation tests. The expected settlements would not exceed the estimated settlements calculated during design.

SEEPAGE

10.03 Record testing indicated that the permeabilities of the core and random materials of the as-built embankment fall within the range of the assumed design permeabilities. Therefore, through seepage analyses will not vary significantly from the design analyses. See figures 10 and 11 for design seepage analysis.

XI. DIVERSION AND CONTROL OF WATER

11.01 The diversion and control of water consisted of staged construction of the embankment and construction of diversion levees to pass floodflows of 24,000 cfs. Stage 1 embankment consisted of constructing the upstream portion of the embankment to El. 1355 at Sta. 21+00 to El. 1371 at Sta. 70+00. Temporary diversion levees (West Diversion and East Diversion Levees) were constructed to protect the outlet and abutment construction and the below ground embankment construction. The West Diversion Levee is a ring dike, surrounding the outlet and abutment, tying into the abutment upstream and downstream of the outlet works. The East Diversion Levee ties into the Stage 1 embankment and is located at embankment Sta. 20+50. The diversion and control of water left a breach of 480 feet in the embankment at the right abutment.

11.02 Closure of the breach commenced on 18 November 1981. The contractor worked on an accelerated schedule to construct the embankment to El. 1378 by 2 December 1981, see photo 64. The embankment was topped out on 31 December 1981, see photo 65.

XII. INSTRUMENTATION

12.01 Instrumentation consisted of installing 31 settlement monuments. A monument was installed in each abutment. Twenty-four monuments were installed at the upstream edge of the crest to monitor crest settlement. Five monuments were installed on the upstream slope to monitor slope movements. See plate 35 for location of settlement monuments. In addition 9 of the 13 monuments installed in 1977 downstream of the embankment to monitor subsidence are in place.

XIII. CONSTRUCTION NOTES

CHANGES AND MODIFICATIONS

13.01 Changes and modifications were made during construction to utilize available equipment and construction materials and due to conditions not anticipated during design. The geotechnical related contract modifications and field changes are listed in tables 4 and 5. Also listed in table 6 are obligated bid items with significant quantity changes.

TABLE 4

FIELD CHANGES

Item	Date	Description	Cost
Gravel	23 Jan 1981	Modify specified gradation to allow contractor to produce gravel from spillway excavation and gravel waste pile	No Cost
Type III Stone	3 Feb 1981	Modify specified gradation to use crushed material from spill-way excavation	No Cost
Core	18 March 1981	Increase lift thickness from 8" to 12" and reduce number of passes from 8 to 6	No Cost
Random	10 April 1981	Widen random zone between core and gravel chimney from 12' to 15' to minimize contamination of gravel chimney by 651B scrapers	No cost
Type I and II Stone	16 Sept 1981	Replace Type I with Type II Stone between El. 1372.8 to 1393.0 as a result of reevaluation of stone protection	$107,388 Credit

TABLE 5
GEOTECHNICAL RELATED CONTRACT MODIFICATIONS

MOD. NO.	Item	Description of Change	Negotiated Cost
P00005	Investigate right abutment	Drill 20 probe holes and clean 40x40 foot area	13,141.00
P00006	Concrete leveling slab	Place concrete leveling slab in outlet conduit, intake structure and energy dissapator from station 76+54, 910 cy	68,250.00
P00008	Revised abutment excavation	Drill and blast abutment surface; pioneer trail; blast over steepened slope	43,125.00
P00009	Abutment Filter	Place 4420.45 cy of filter sand on downstream portion of abutment contact beneath gravel drain blanket	97,560.00
P00010	Irregular abutment surface	Additional work required to properly excavate the abutment due to irregular surface	43,125.00
P00011	Revised outlet costs	Additional cost to use 4x4-foot drill pattern; air cleaning and dental excavation of demonstration blast area	32,013.00
P00014	Delays due to irregular abutment surface	Additional costs due to delays caused by irregular abutment surface	49,625.00
P00015	Additional costs for foundation drilling and grouting	Ream out and deepen D-11; establish waste water control system; move and set-up drilling equipment over irregular abutment surface	5,851.00
P00018	Compaction of core material at abutment contact	Additional costs to use CDE specified equipment (front-end loader and hand tampers) to compact core materials at abutment contact	10,000.00
		Total	363,060.00

TABLE 6

MODIFIED QUANTITIES

Contract Item No.	Item Description	Quantities Original	Quantities Actual	Cost Increase
10B	Excavation Dental, over 100 cy	50 cy	5,717 cy	$340,020.00
38B	Dental Concrete over 60 cy	65 cy	910 cy	$ 76,050.00
43H	Foundation Drilling Grouting, Placing Grout	200 sacks	4,744 sacks	$136,320.00

CONSTRUCTION EQUIPMENT

13.02 The equipment used during the construction of Adobe Dam varied with the particular phase of the job being performed. The construction equipment used by the contractor during the construction of Adobe Dam is listed in table 6. Much of this equipment can be seen in the photographs accompanying this report. Only a portion of this equipment was used throughout the duration of construction.

TABLE 7

CONSTRUCTION EQUIPMENT

EQUIPMENT DESCRIPTION	EQUIPMENT NUMBER
Terex S-24	1312-10
Terex S-24	1314-10
Terex S-24	PS-40
Terex S-24	PS-60
Dozer, Cat D-9H	KE-116
Dozer, Cat D-9H	KE 117
Dozer, Cat D-9H	KE 118
Dozer, Cat D-9H	KE 121
Dozer, Cat D-9H	KE 116
Dozer, Cat D-9G	KE 111
Dozer, Cat D-8H	KD 100
Dozer, Cat D-8K	RE 6472
Dozer, Cat D-6	KD 97
Dozer, Cat D-8H	KD 109
Dozer, Cat D-8H	KD 71
Scraper, Cat 651-B	PS 56
Scraper, Cat 651-B	PS 68
Scraper, Cat 651-B	PS 72
Scraper, Cat 651-B	PS 74
Scraper, Cat 651-B	PS 75

TABLE 7

CONSTRUCTION EQUIPMENT
(Continued)

EQUIPMENT DESCRIPTION	EQUIPMENT NUMBER
Scraper, Cat 623-B	RE 6476
Scraper, Cat 623-B	PS 78
Water Pull, Cat 651	WA 1249
Water Pull, Cat 651	WA 1228
Water Truck 4000 g	WA 120
Water Truck 4000 g	WA 1270
Water Truck 10000 g	WA 1248
Water Tank Truck	WA 1238
Water Tank Truck	WA 1231
Water Trailer	TW 193
Water Tank	WR-13
Grader	GR-48
Grader	GR-50
Grader	GA-57
Loader, Cat 988B	RE 6586
Loader, Cat 977L	RE 6812
Loader, Cat 977L	N14176R
Loader, Cat 824B	LP 112
Loader, Cat 920	L 66
Loader, Cat 966C	L 141
Loader, Cat 966D	RE 6829
Loader, Cat 966C	L 142
Loader, Cat 980C	L 162
Grade-All	G 1000
Roller, Vib	RE 6707
Roller, Vib	RE 6830
Roller, Vib	713 R
Roller, 8-wheel	140-547
Roller, 50-Ton	RP 40
Roller, 50-Ton	RP 46
Roller, Sheepsfoot	RS 50
BG-Land Grader	KW 120
Crane, 70-Ton	
Crane, Link Belt 150-Ton	LS-518
Rock Truck, End Dump	1013
Rock Truck, End Dump	ST1304
Rock Truck, End Dump	ST1306
Rock Truck, End Dump	ST1314
Rock Truck, End Dump	St1312
Rock Truck, End Dump	ST1316
Rock Truck, End Dump	ST1325
Rock Truck, End Dump	ST1326
Rock Truck, End Dump	K-21
Rock Truck, End Dump	K-22
Rock Truck, Bottom Dump	W-17

TABLE 7

CONSTRUCTION EQUIPMENT
(Continued)

EQUIPMENT DESCRIPTION	EQUIPMENT NUMBER
Rock Truck, Bottom Dump	W 150
Rock Truck, Bottom Dump	W 158
Rock Truck, Bottom Dump	W 165
Rock Truck, Bottom Dump	
Rock Truck, Bottom Dump	1276
Rock Truck, Bottom Dump	1326
Rock Truck, Bottom Dump	1327
Rock Truck, Bottom Dump	1328
Rock Truck, Bottm Dump	1241
Rock Truck, Bottom Dump	1250
Rock Truck, Bottom Dump	1279
Rock Truck, Bottom Dump	1312
Backhoe, Case 880 B	RE 6788
Backhoe, JCB 3D	RE 6414
Backhoe, Case 580 C	RE 7099
Backhoe, Case 580 C	01-0021
Backhoe, Case 580 C	01-0019
Backhoe, Case	01,0020
Backhoe, Case	01-0490
Backhoe, Cat 23 Track	SH-16
Backhoe, Case 580 K	01-0947
Forklift	L87
Forklift, MF-4500	08-0162
Bobcat, Case	1835
Grout Plant	
Compressor, I-R	OC-134
Compressor, I-A 400	RE 7097
Compressor, I-R 850	93020
Compressor	R7131
Portable Pump	P106
Generator, 5000 W	GE 272
Generator, 3500 W	332
Generator, Homelite	GE 316
Generator, 3500 W	GE 240
Drill, Air Track	RE 6930
Drill, CP-65	
Drill, CP-65	
Jackhammers	
Compactor, Whackers (2)	Rental
Compactor, Vibro-Roller (3)	Rental
Roto Tiller	Rental
Tractor, Ford	Rental
Compactor, Pogo Stick	Rental
Compactor, Jumping Jack	Rental
Vibrator	VIB 8000
Sand Blaster	CE 110
Flatbed Truck	DF 1092

XIV. RECOMMENDATIONS AND CONSIDERATIONS

14.01 During various construction phases of the embankment some items applicable to future design and preparation of specifications were noted. The following items may be helpful on other project design and specifications preparation.

a. Minimum construction widths on large earthwork projects should be 14 feet for excavation and 15 feet for any embankment zone where costs and material availability are not factors. The Cat 651B Scrapers had an overall width of 14'2". The wider placement zone width would minimize contamination of adjacent embankment materials.

b. A well defined verification fill should be required by the specifications to verifiy and demonstrate the contractor's fill construction procedures consisting of placement, spreading, compacting and scarifying. This would aid the contractor and inspection personnel in embankment construction control.

c. Where moisture is required to raise the moisture content of the borrow materials to obtain the specified range of moisture, prewetting the borrow area should be incorporated as a specification requirement. Prewetting would minimize the moisture control problems associated with adding moisture on grade to dry materials.

d. Placement of embankment materials against the abutment should be well defined in the specification. The moisture content (+ opt), lift thickness, method of placement and compaction should be incorporated into the specifications to obtain the required embankment to abutment contact.

e. Dental excavation needs to be well defined in the specifications so that field personnel and contractors can identify and quantify dental excavation quantities.

f. The procedure and extent of abutment cleaning should be well defined in the specifications to prevent conflicts with the contractor. The specifications should define the extent and type of cleanup required of prepared surfaces prior to placement of embankment materials.

g. Where soils are coarse, consisting of silty and clayey sands and gravels with cobbles and boulders, two passes of ripper teeth spaced at 9 inches on centers are preferable to a disc to scarify the surface.

h. The use of a specified placement method should be considered based upon the type of stone protection available. Where rounded rock is the only available slope protection, placement with gradall or backhoe, as the embankment is constructed, should be specified to obtain a dense tightly packed stone layer.

i. On future projects, serious consideration should be given to deleting topsoil fill on stone protection. The topsoil fill does not effectively hide or camouflage the embankment as envisioned by the landscape architect. Also, clogging of the drainage blanket could result from topsoil fill washing into the drainage blanket outlet. The topsoil fill should be designed to be compatible with the stone protection to preclude particle migration.

XV. SUMMARY

15.01 The embankment was constructed in accordance with plans and specifications. Based upon record test results the as-built embankment meets or exceeds design requirements. The well constructed embankment is the direct result of the excellent cooperation between design and construction personnel.

PHOTOS

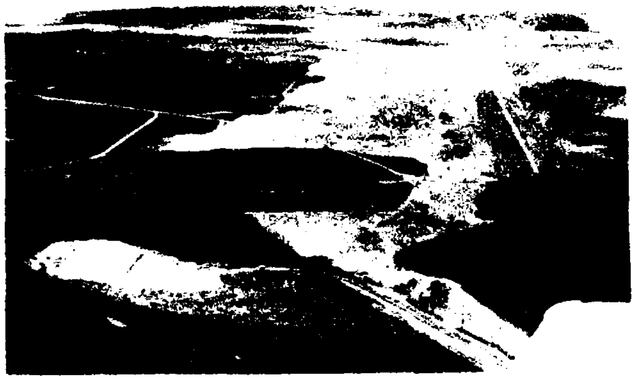


Photo 1
View of Completed Project

Photo 2
View of Completed
Outlet Channel

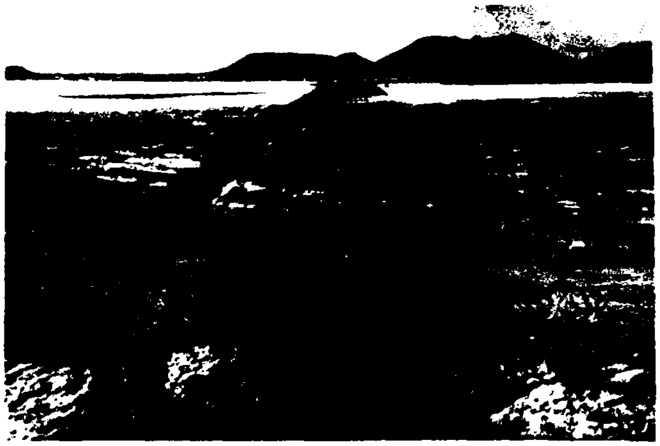


Photo 3
Prewetting of Embankment Foundation

Photo 4
Foundation Excavation

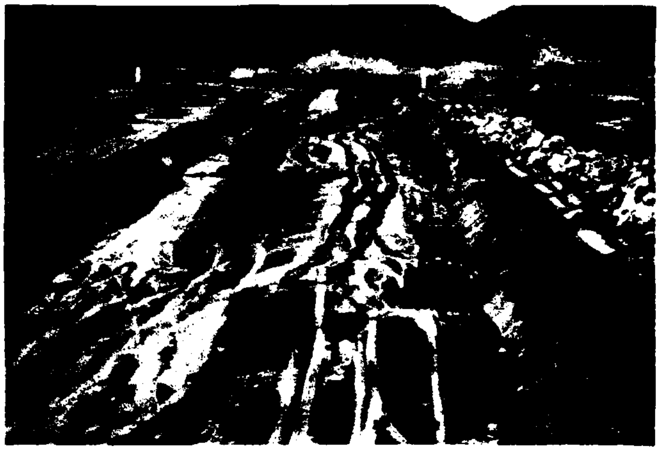


Photo 5
Completed Foundation Excavation
(from Left Abutment)

Photo 6
Exploration Trench Excavation

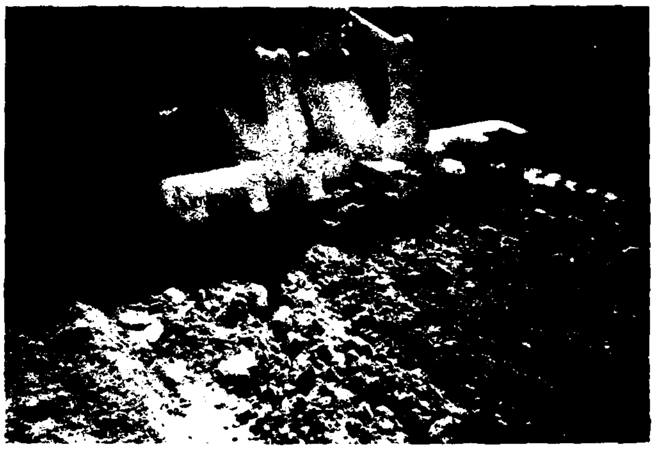


Photo 7
Scarifying Equipment

Photo 8
Scarifying of Exploration Trench and
Foundation Rolling

Photo 9
Foundation Rolling with 50-Ton Rubber Tire Roller

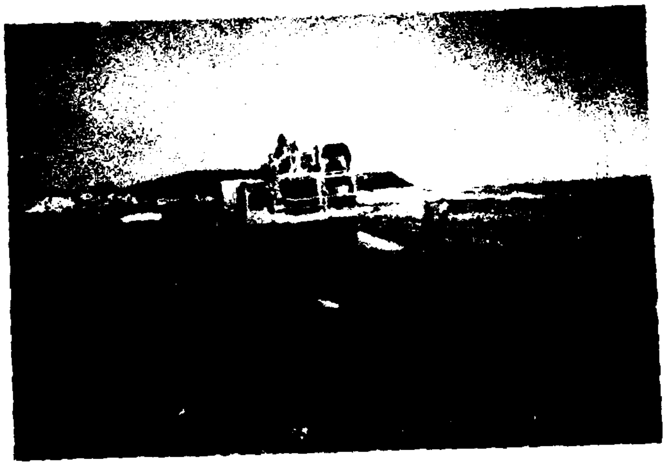


Photo 10
Adjusting Foundation Moisture

Photo 11
Typical Foundation Materials Encountered
in the Exploration Trench

Photo 12
Right Abutment Stripping

Photo 13
Drilling Blast Holes on Right Abutment

Photo 14
Blast No. 14A at Right Abutment

Photo 15
Removal of Blast Loosened Abutment Excavation Material with D9-H

Photo 16
Placing Toe Stone in Upstream Toe Trench

Photo 17
Excavated Abutment Surface
(Before Cleaning)

Photo 18
Right Abutment, Excavating 40x40 Feet
Inspection Area

Photo 19
Inspection of 40x40 Feet Cleaned Area

Photo 20
Inspection of 40x40 Feet Cleaned Area

Photo 21
Typical Right Abutment Foundation Surface

Photo 22
Cleaned Right Abutment Surface and
Start of West Core Trench

Photo 23
Dental Concrete

Photo 24
Dental Concrete

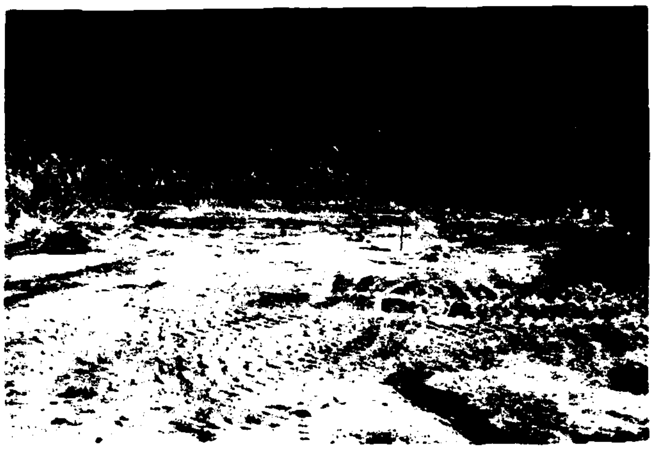


Photo 25
Left Abutment Foundation Surface

Photo 26
Excavation of Random Materials

Photo 27
Rock Crusher and Gravel Drain Material
Produced from Spillway Excavation

Photo 28
Typical Rock Waste Pile

Photo 29
Typical Rock Waste Pile

Photo 30
Type I Stone Grizzly

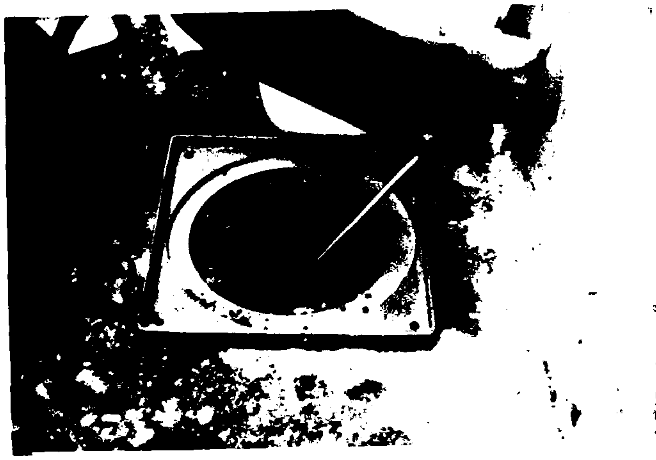


Photo 31
Sand Cone Density

Photo 32
Large Scale Density Truck

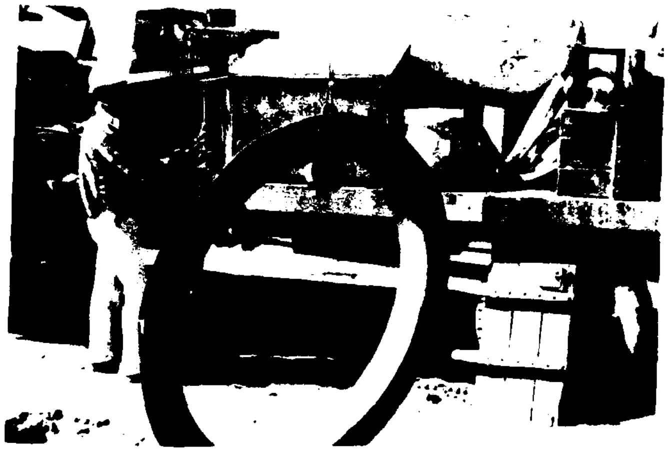


Photo 33
Large Scale Density Ring
(48-Inch Diameter)

Photo 34
Filling the Density Hole with Water

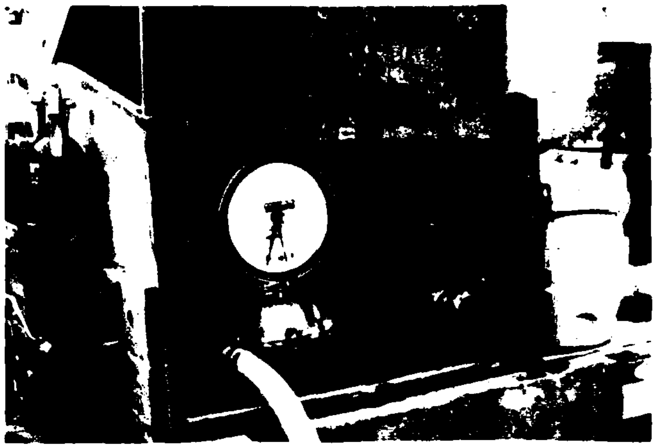


Photo 35
Water Meter to Measure Volume

Photo 36
Water Level Gage Point

Photo 37
Undisturbed Cubic Foot Record Sample

Photo 38
Undisturbed Cubic Foot Record Sample

Photo 39
Compaction of Core Materials in Core Trench

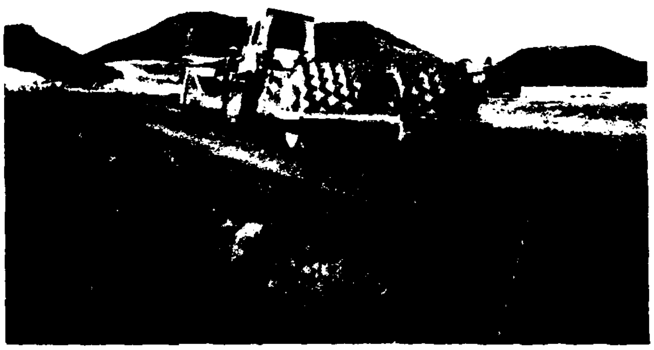


Photo 40
Compaction of Core Materials

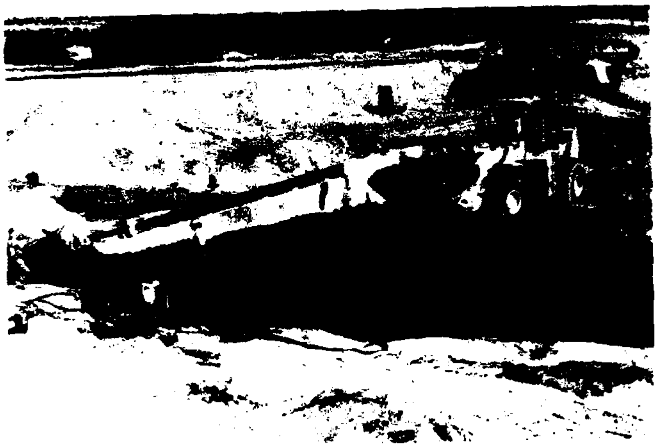


Photo 41
Compaction of Core Materials at
the Right Abutment

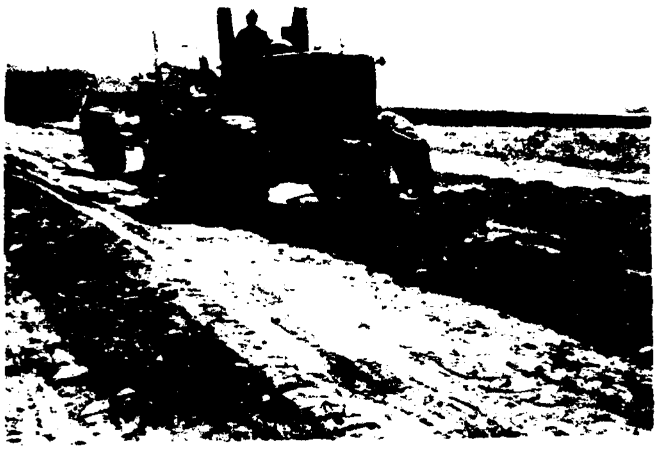


Photo 42
Scarifying Random Materials

Photo 43
Windrowing of Oversize

Photo 44
Towed Vibratory Roller

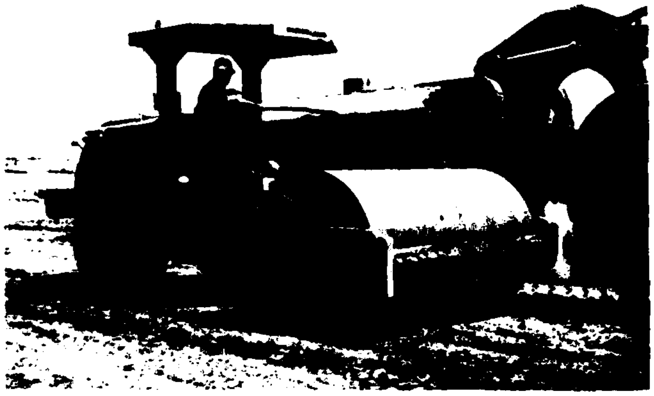


Photo 45
Self Propelled Vibratory Roller

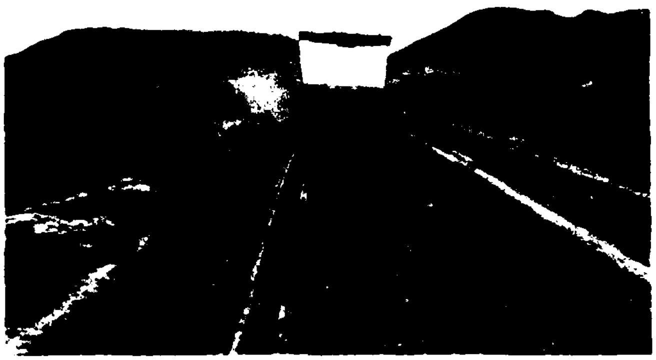


Photo 46
Placing Gravel Chimney Drain

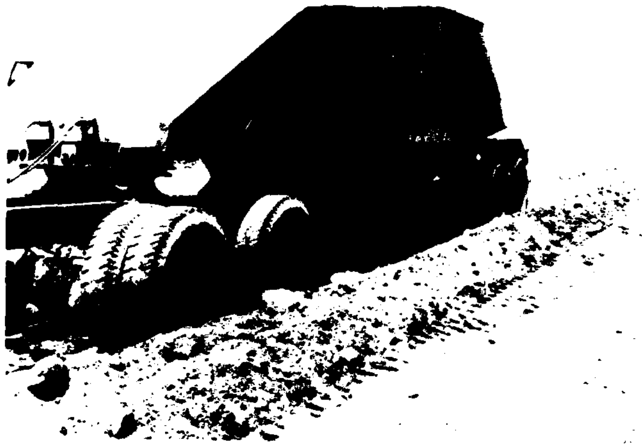


Photo 47
Placing Gravel Drain Chimney

Photo 48
Spreading Gravel
Drain Material

Photo 49
Placing Filter Material

Photo 50
Placing Bedding with a Front End Loader

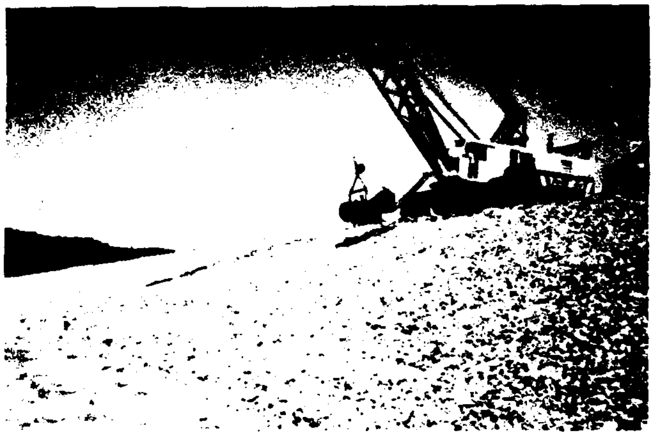


Photo 51
Placing Bedding with 70-Ton Crane
and Drag Bucket

Photo 52
150-Ton Link Belt Crane

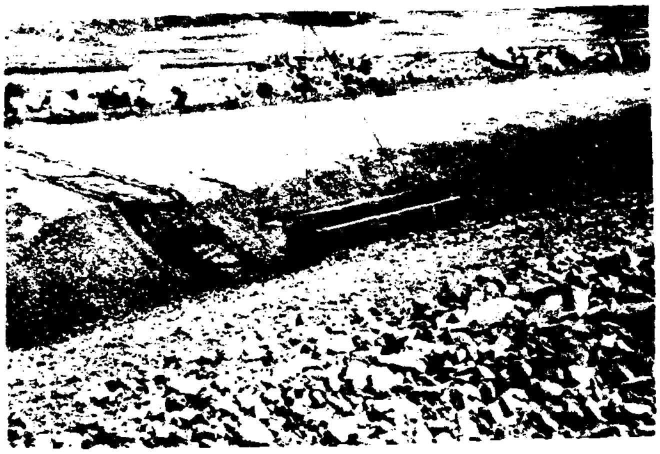


Photo 53
Placing Bedding with BG Blade

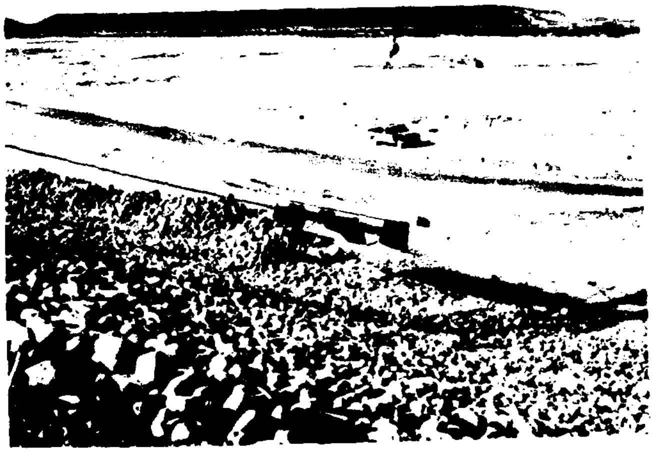


Photo 54
Placing Type I Stone with a BG Blade

Photo 55
View of Spillway Prior to Excavation

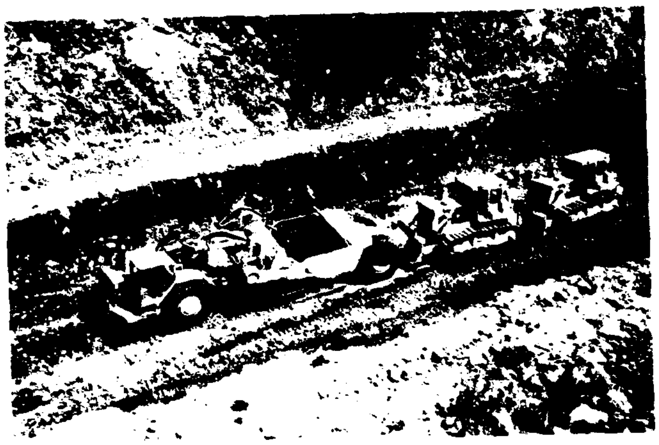


Photo 56
Excavation of Spillway

Photo 57
Trimming of Spillway Slopes

Photo 58
Trimming of Spillway Slopes

Photo 59
Excavated Outlet Trench

Photo 60
Dental Excavation of Outlet Trench

Photo 61
Concrete Leveling Pad

Photo 62
Concrete Plug, Outlet Conduit

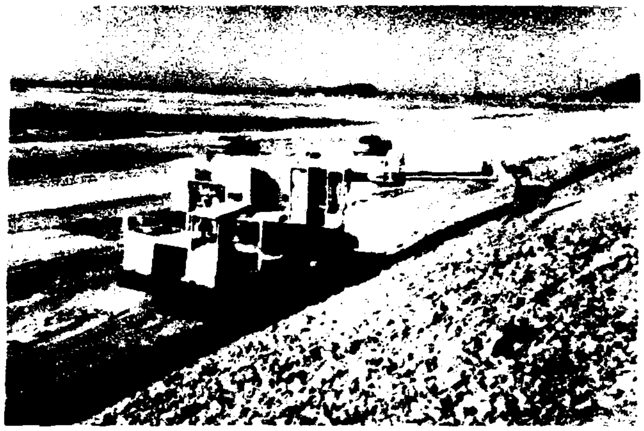
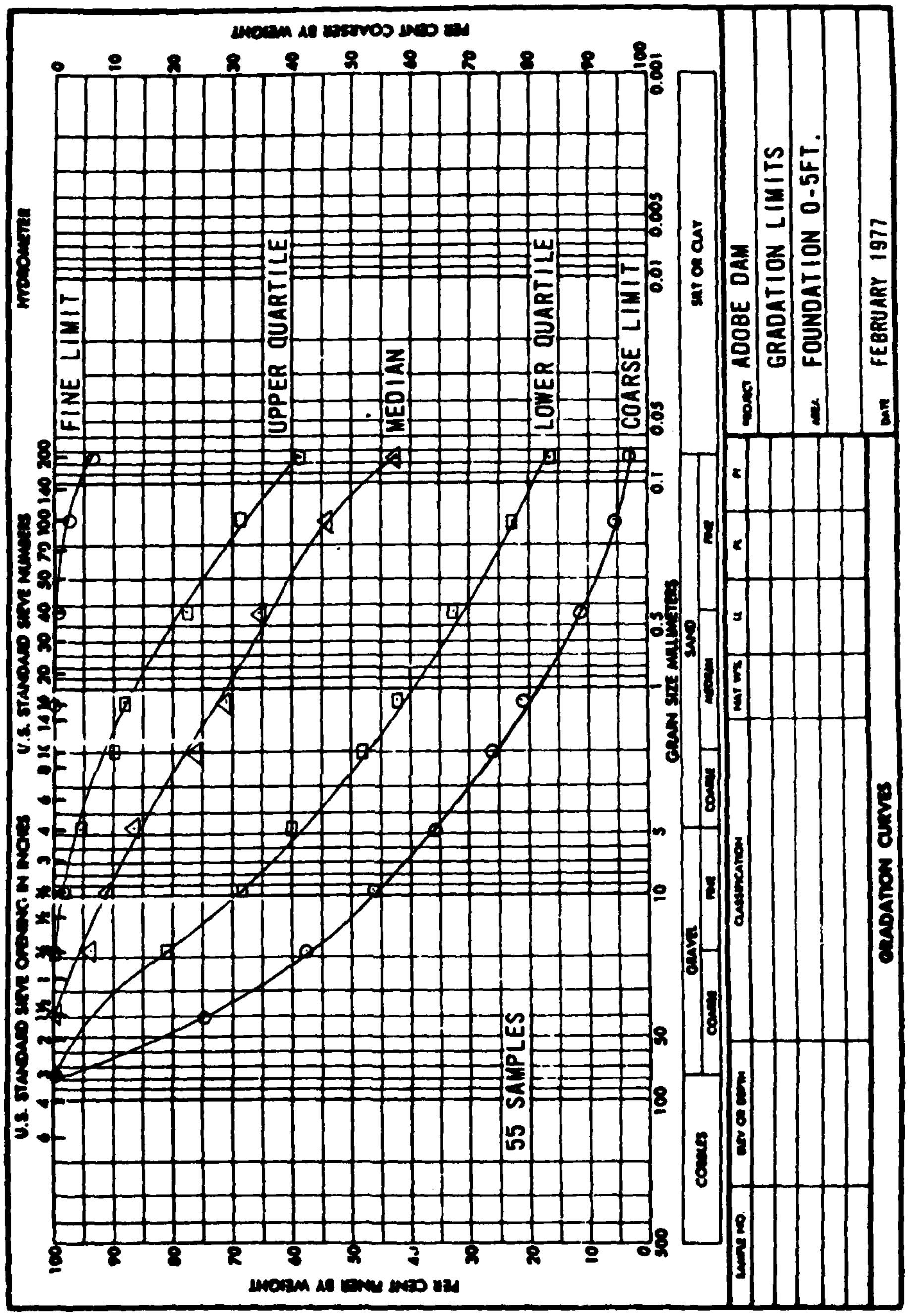


Photo 63
Gradall G-1000 Placing Topsoil Fill

Photo 64
Closure Section

Photo 65
Last Loads Being Placed

FIGURES



U.S. STANDARD SIEVE OPENING IN INCHES
U.S. STANDARD SIEVE NUMBERS
HYDROMETER
PER CENT COARSER BY WEIGHT
PER CENT FINER BY WEIGHT
GRAIN SIZE MILLIMETERS
FINE LIMIT
UPPER QUARTILE
MEDIAN
LOWER QUARTILE
COARSE LIMIT
55 SAMPLES
COBBLES
GRAVEL
COARSE
FINE
SAND
COARSE
MEDIUM
FINE
SILT OR CLAY
SAMPLE NO.
ELEV OR DEPTH
CLASSIFICATION
NAT W%
LL
PL
PI
PROJECT ADOBE DAM
GRADATION LIMITS
AREA FOUNDATION 0-5FT.
DATE FEBRUARY 1977
GRADATION CURVES

FIGURE 1

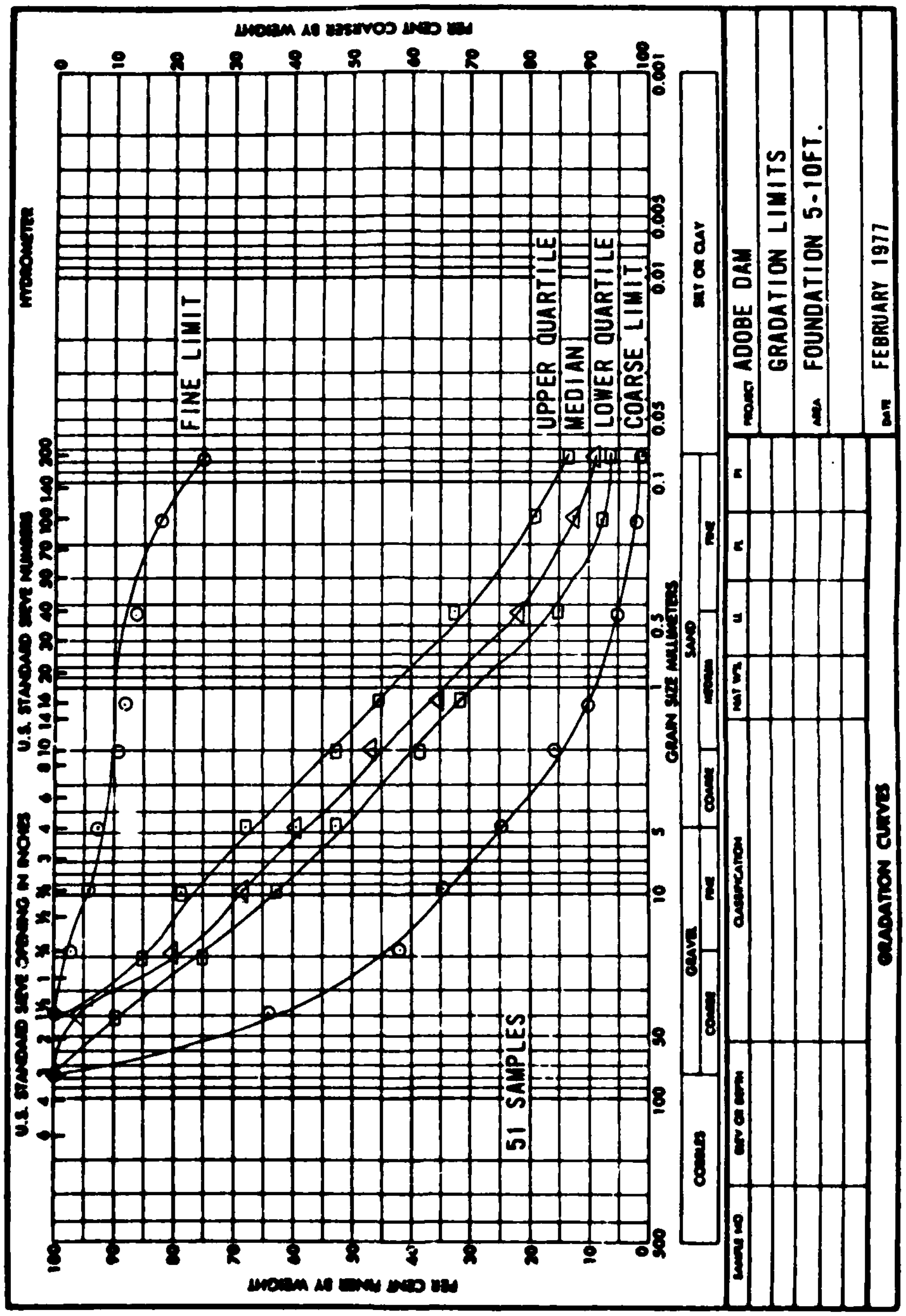
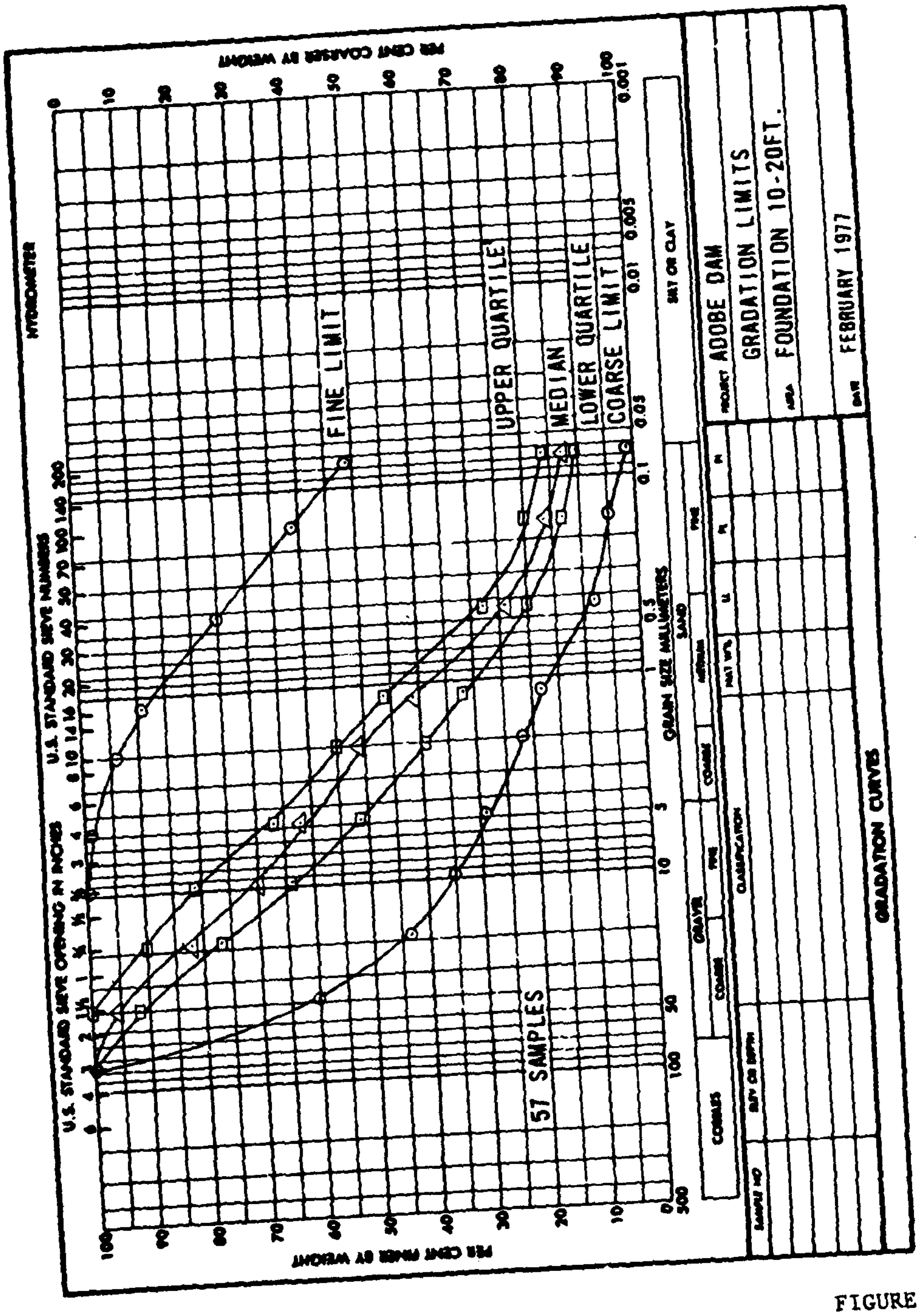
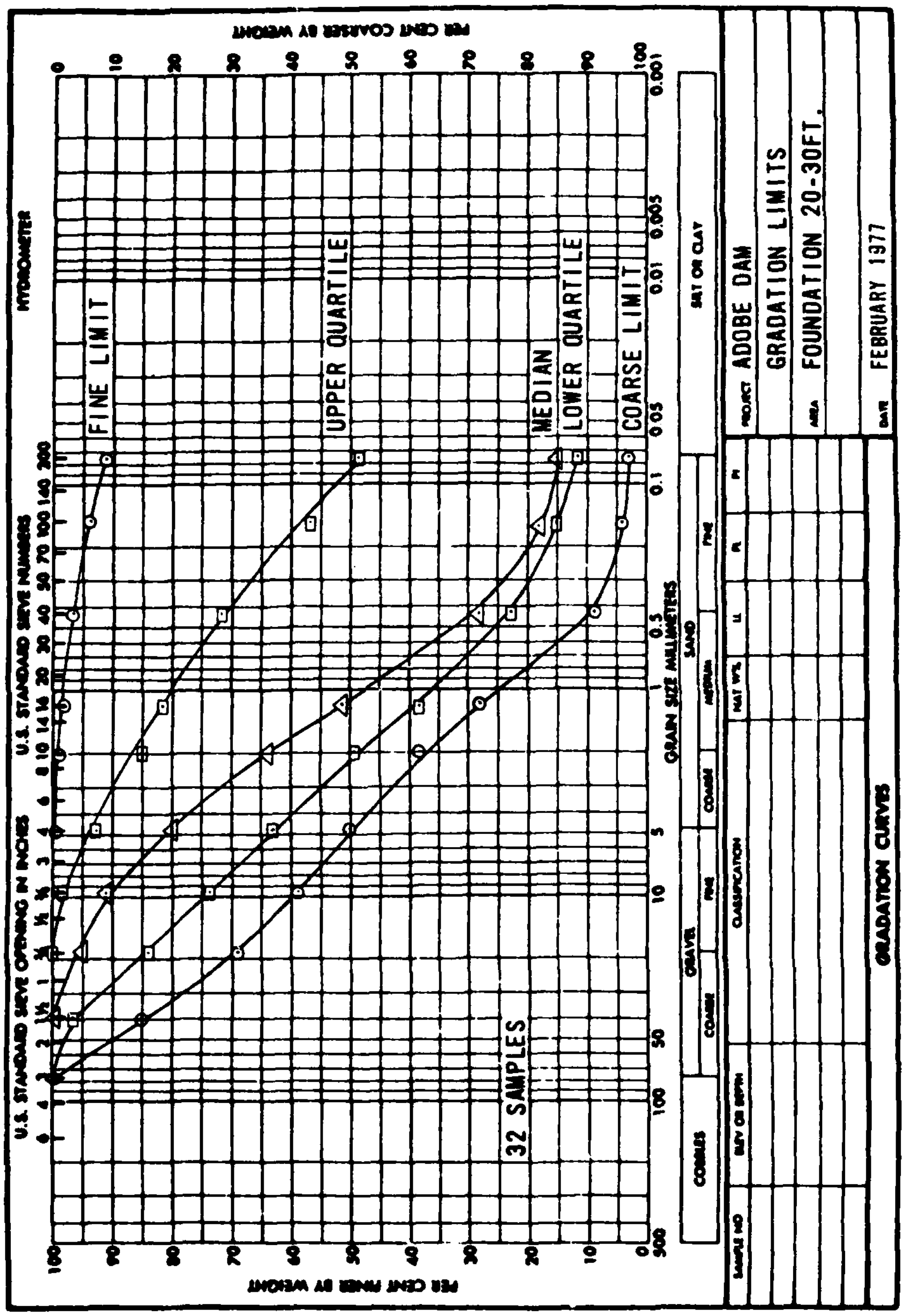

U.S. STANDARD SIEVE OPENING IN INCHES
U.S. STANDARD SIEVE NUMBERS
HYDROMETER
PER CENT FINER BY WEIGHT
PER CENT COARSER BY WEIGHT
GRAIN SIZE MILLIMETERS
COBBLES
GRAVEL
SAND
SILT OR CLAY
FINE LIMIT
UPPER QUARTILE
MEDIAN
LOWER QUARTILE
COARSE LIMIT
51 SAMPLES
PROJECT ADOBE DAM
GRADATION LIMITS
AREA FOUNDATION 5-10FT.
DATE FEBRUARY 1977
GRADATION CURVES

FIGURE 2



HYDROMETER
U.S. STANDARD SIEVE OPENING IN INCHES
U.S. STANDARD SIEVE NUMBERS
PER CENT COARSER BY WEIGHT
PER CENT FINER BY WEIGHT
GRAIN SIZE MILLIMETERS
FINE LIMIT
UPPER QUARTILE
MEDIAN
LOWER QUARTILE
COARSE LIMIT
57 SAMPLES
COBBLES
GRAVEL
SAND
SILT OR CLAY
PROJECT ADOBE DAM
GRADATION LIMITS
AREA FOUNDATION 10-20FT.
DATE FEBRUARY 1977
GRADATION CURVES

FIGURE 3



U.S. STANDARD SIEVE OPENING IN INCHES
U.S. STANDARD SIEVE NUMBERS
HYDROMETER
PER CENT FINER BY WEIGHT
PER CENT COARSER BY WEIGHT
GRAIN SIZE MILLIMETERS
FINE LIMIT
UPPER QUARTILE
MEDIAN
LOWER QUARTILE
COARSE LIMIT
32 SAMPLES
COBBLES
GRAVEL
COARSE
FINE
SAND
COARSE
MEDIUM
FINE
SILT OR CLAY
SAMPLE NO
ELEV OR DEPTH
CLASSIFICATION
NAT W%
LL
PL
PI
PROJECT ADOBE DAM
GRADATION LIMITS
AREA FOUNDATION 20-30FT.
DATE FEBRUARY 1977
GRADATION CURVES

FIGURE 4

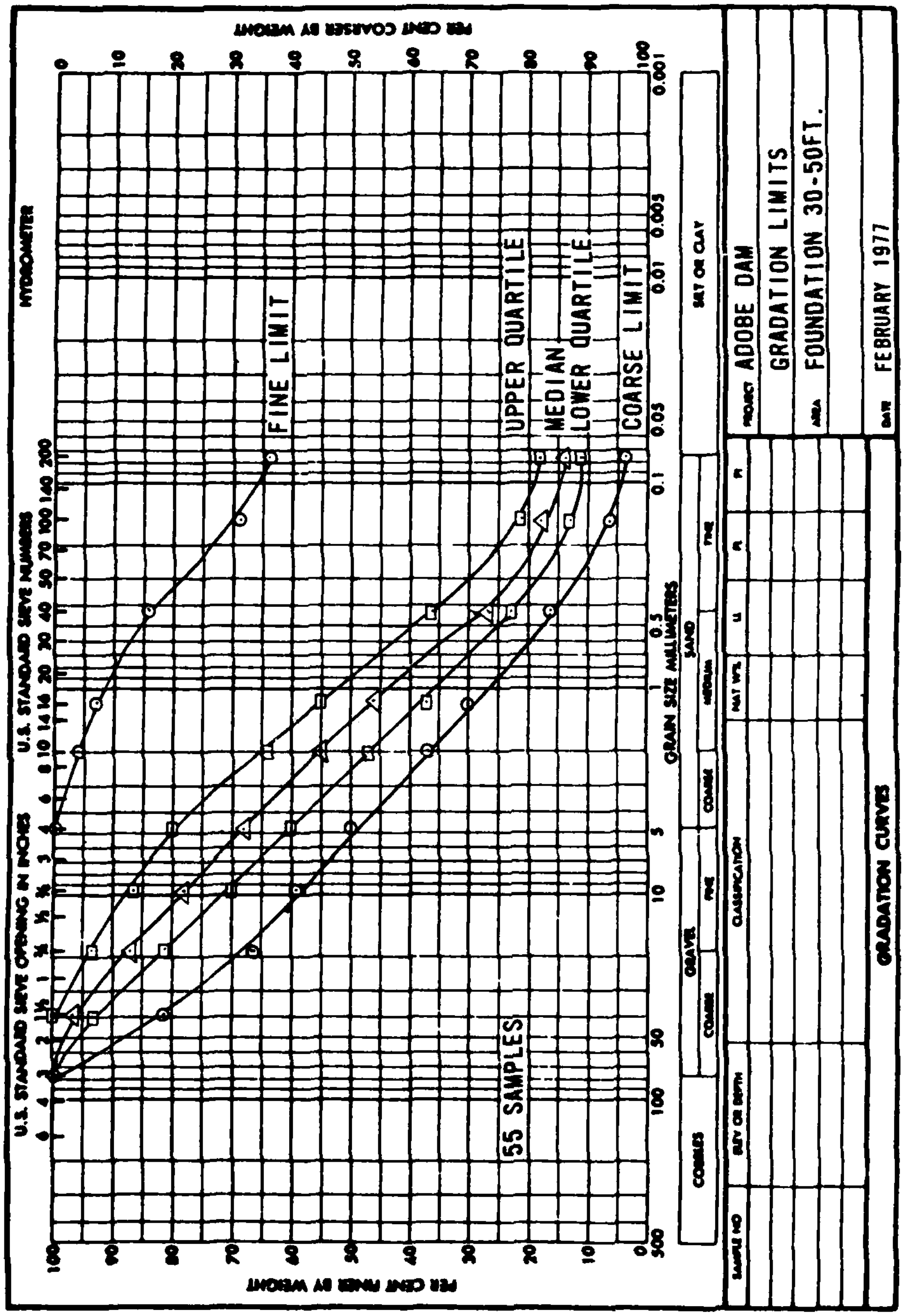

U.S. STANDARD SIEVE OPENING IN INCHES
U.S. STANDARD SIEVE NUMBERS
HYDROMETER
PER CENT COARSER BY WEIGHT
PER CENT FINER BY WEIGHT
GRAIN SIZE MILLIMETERS
FINE LIMIT
UPPER QUARTILE
MEDIAN
LOWER QUARTILE
COARSE LIMIT
55 SAMPLES
COBBLES
GRAVEL
COARSE
FINE
SAND
COARSE
MEDIUM
FINE
SILT OR CLAY
PROJECT ADOBE DAM
GRADATION LIMITS
AREA FOUNDATION 30-50FT.
DATE FEBRUARY 1977
GRADATION CURVES

FIGURE 5

COMPUTATION SHEET

PROJECT Adobe Dam — SHEET NO. 1 OF 1 SHEETS

ITEM Plasticity Chart - Embankment Foundation 0-5' — DATE January 1977

FILE

COMPUTED BY B.O. — CHECKED BY T.Y. — REF. DRWG. NO.

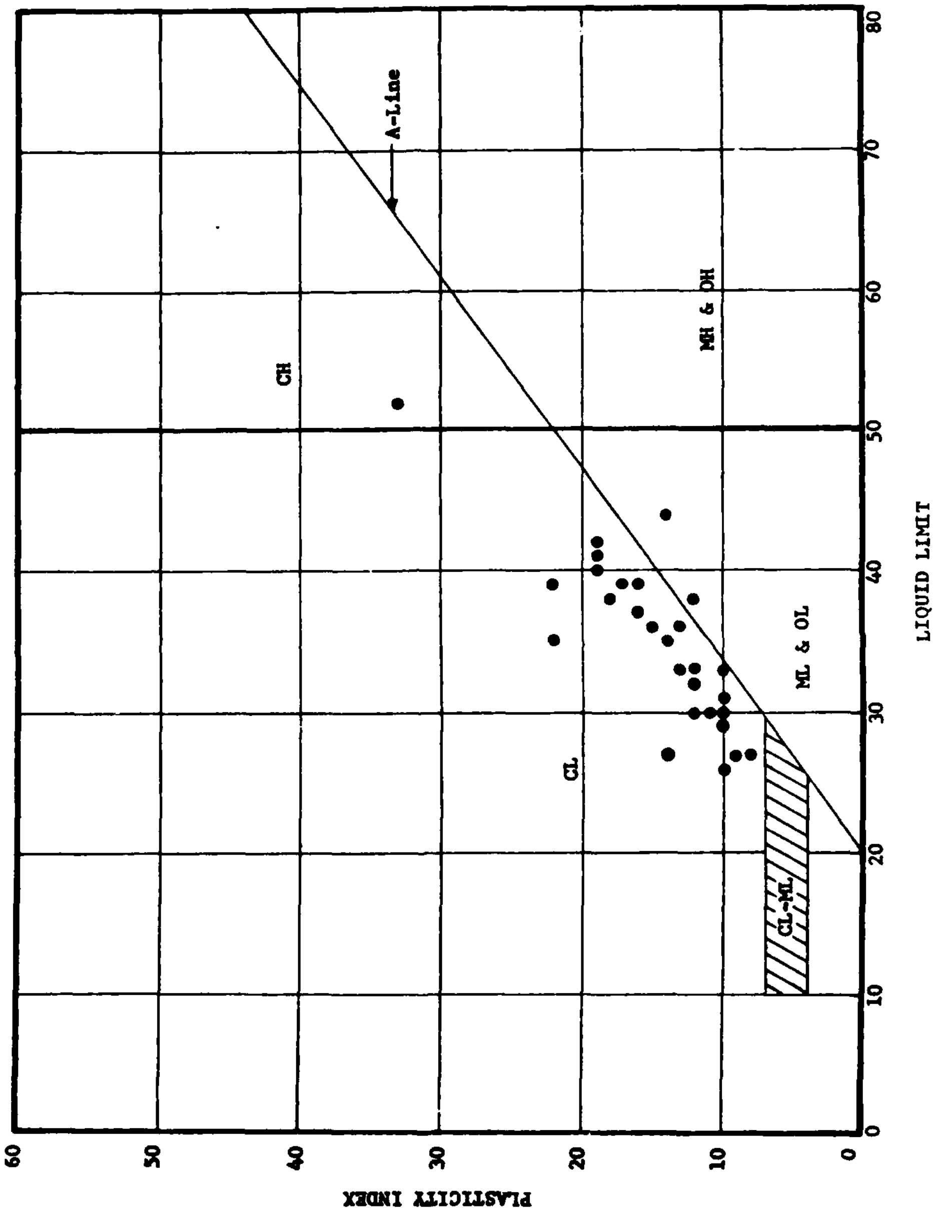


FIGURE 6

COMPUTATION SHEET

PROJECT Adobe Dam — SHEET NO. 1 OF 1 SHEETS

ITEM Plasticity Chart - Embankment Foundation 5' - 25' — DATE January 1977

FILE

COMPUTED BY B.O. — CHECKED BY T.Y. — REF.DRWG.NO.

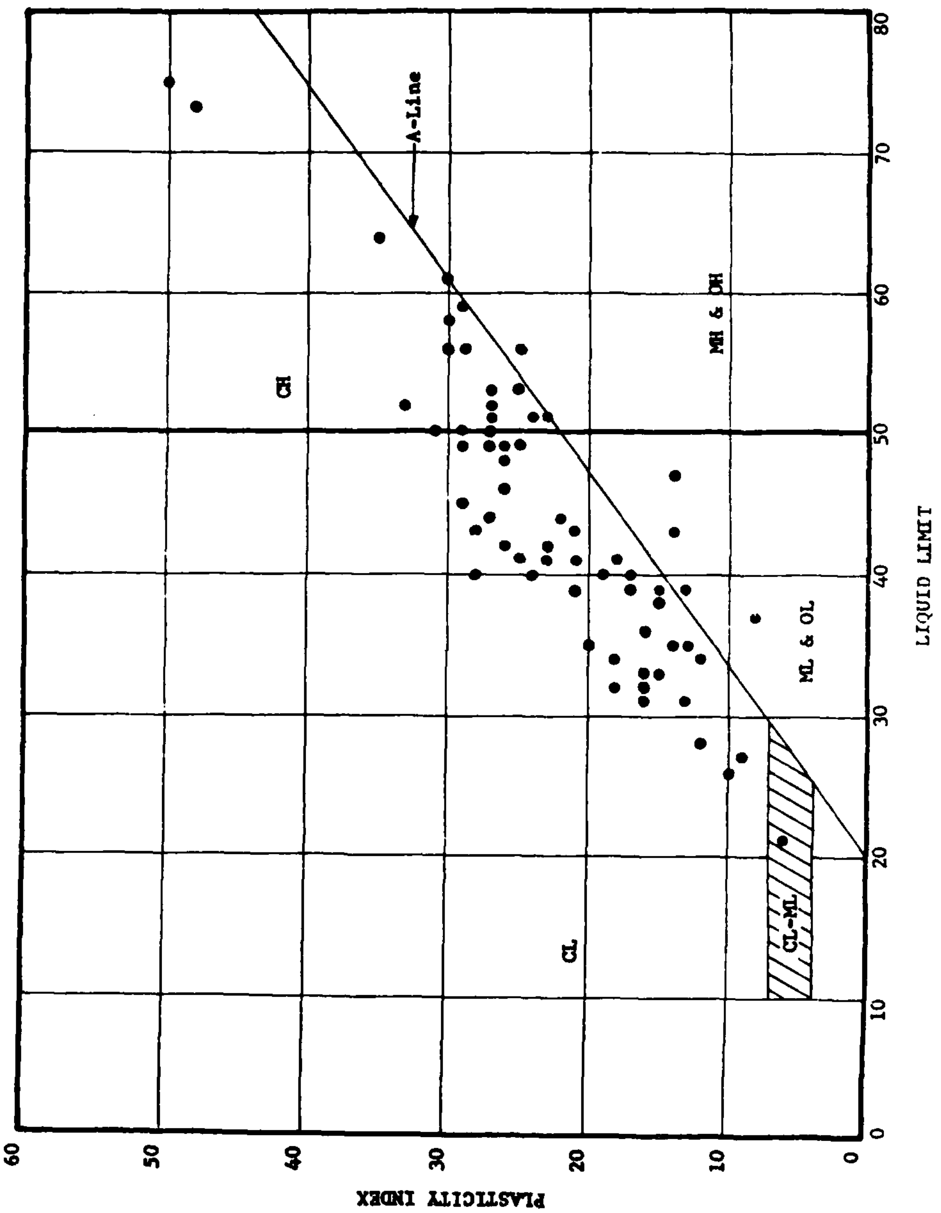


FIGURE 7

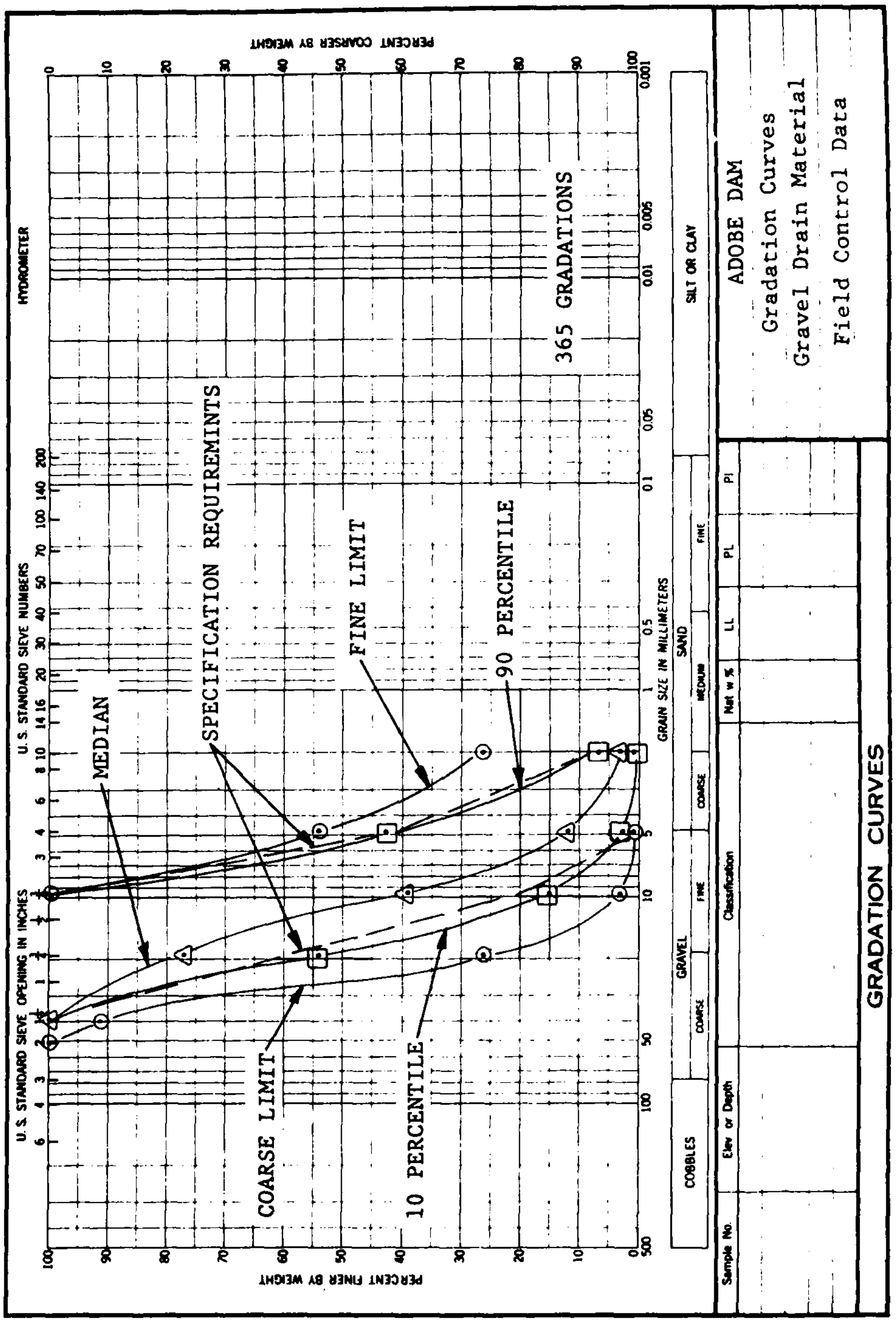

ADOBE DAM
Gradation Curves
Gravel Drain Material
Field Control Data
GRADATION CURVES
365 GRADATIONS
SPECIFICATION REQUIREMINTS
FINE LIMIT
COARSE LIMIT
MEDIAN
90 PERCENTILE
10 PERCENTILE
U. S. STANDARD SIEVE OPENING IN INCHES
U. S. STANDARD SIEVE NUMBERS
HYDROMETER
PERCENT FINER BY WEIGHT
PERCENT COARSER BY WEIGHT
GRAIN SIZE IN MILLIMETERS
COBBLES
GRAVEL
SAND
SILT OR CLAY
Sample No.
Elev or Depth
Classification
Nat w %
LL
PL
PI

FIGURE 8

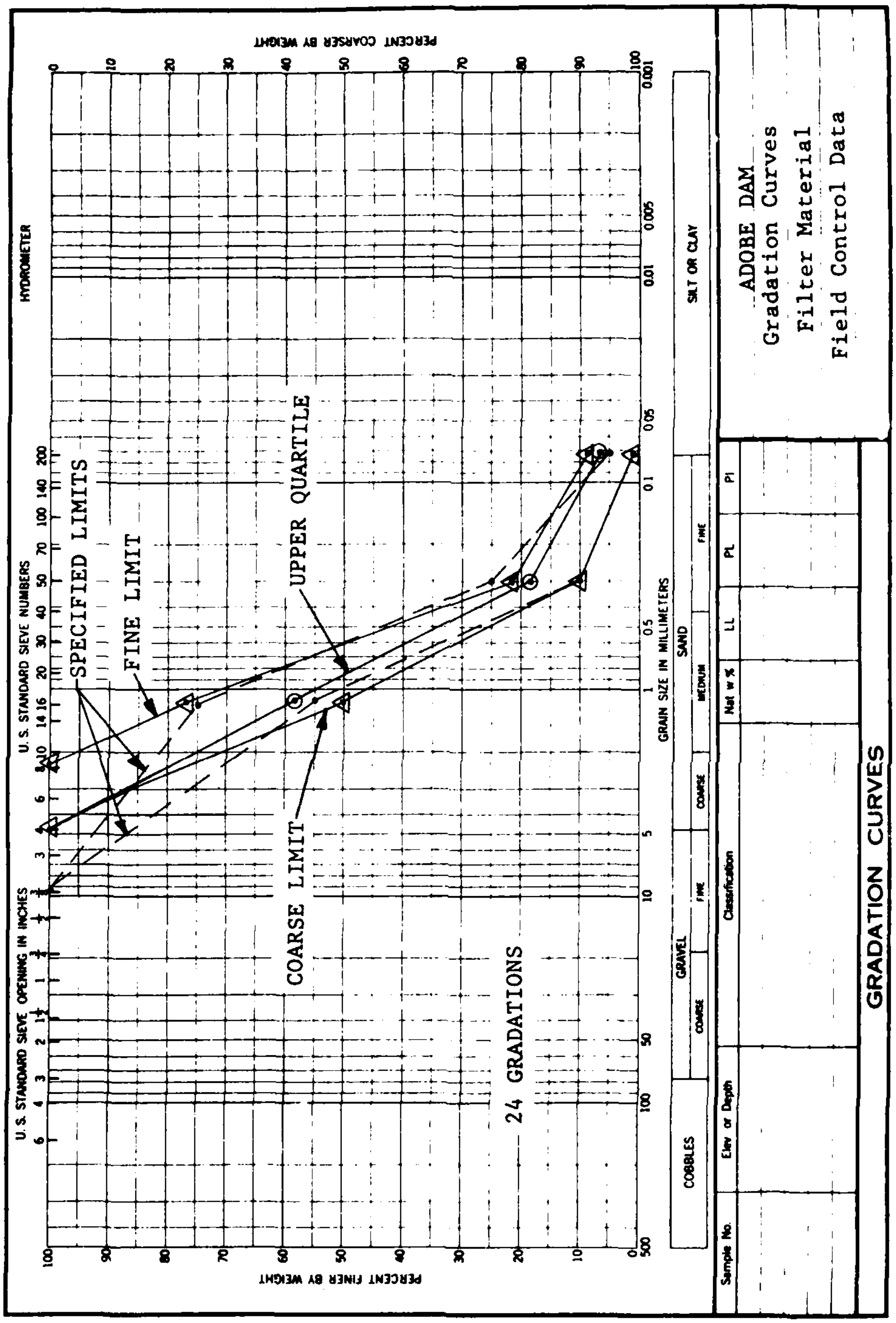
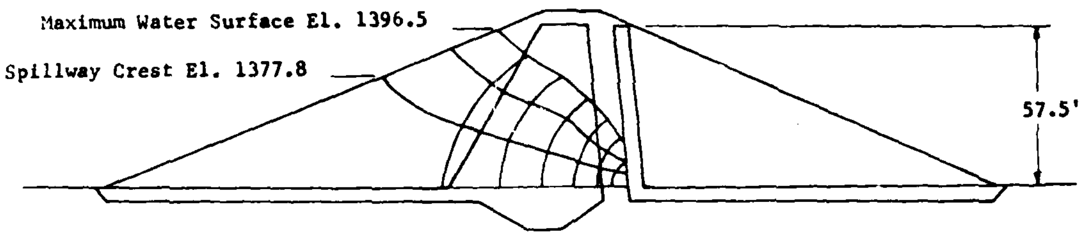

ADOBE DAM
Gradation Curves
Filter Material
Field Control Data
SPECIFIED LIMITS
FINE LIMIT
UPPER QUARTILE
COARSE LIMIT
24 GRADATIONS
U. S. STANDARD SIEVE OPENING IN INCHES
U. S. STANDARD SIEVE NUMBERS
HYDROMETER
PERCENT FINER BY WEIGHT
PERCENT COARSER BY WEIGHT
GRAIN SIZE IN MILLIMETERS
COBBLES
GRAVEL
SAND
SILT OR CLAY
Sample No.
Elev or Depth
Classification
Nat w %
LL
PL
PI
GRADATION CURVES

FIGURE 9



Permeability

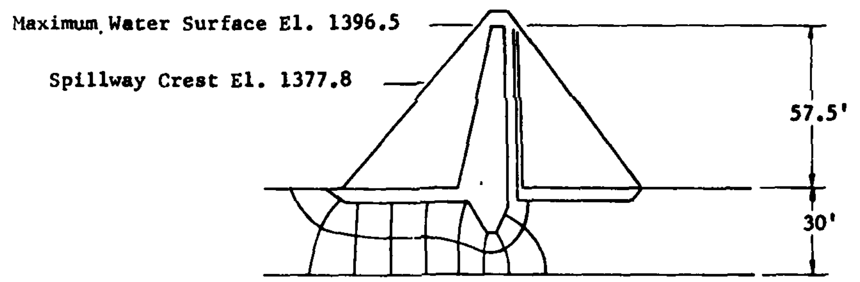
$K_v = K_h = 10$ ft/day

Seepage Rate

$$Q = K\,(n_f/n_e)\,H$$
$$= 10\,(3/7)\,(57.5)$$
$$= 246\ \text{ft}^3/\text{day}/\text{ft}$$

Embankment Through Seepage

FIGURE 10



Effective Permeability

$\bar{K} = \sqrt{K_v K_h}$

$K_h = 9 K_v$

$K_v = 5.5$ ft/day

$K_h = 50$ ft/day

$\bar{K} = 17$ ft/day

Seepage Rate

$Q = \bar{K} (n_f/n_e) H$

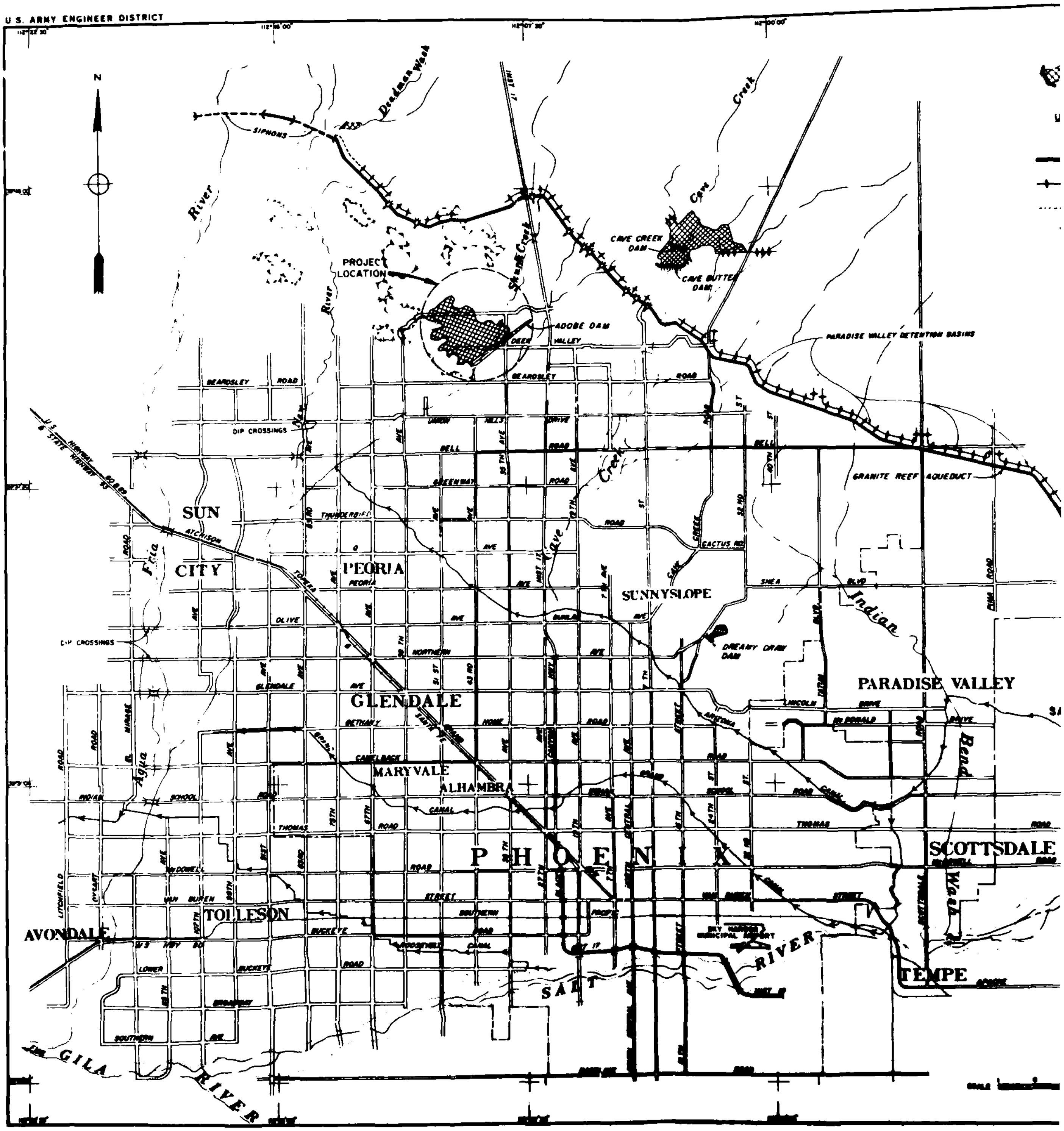
$= 17 (2/9) (57.5)$

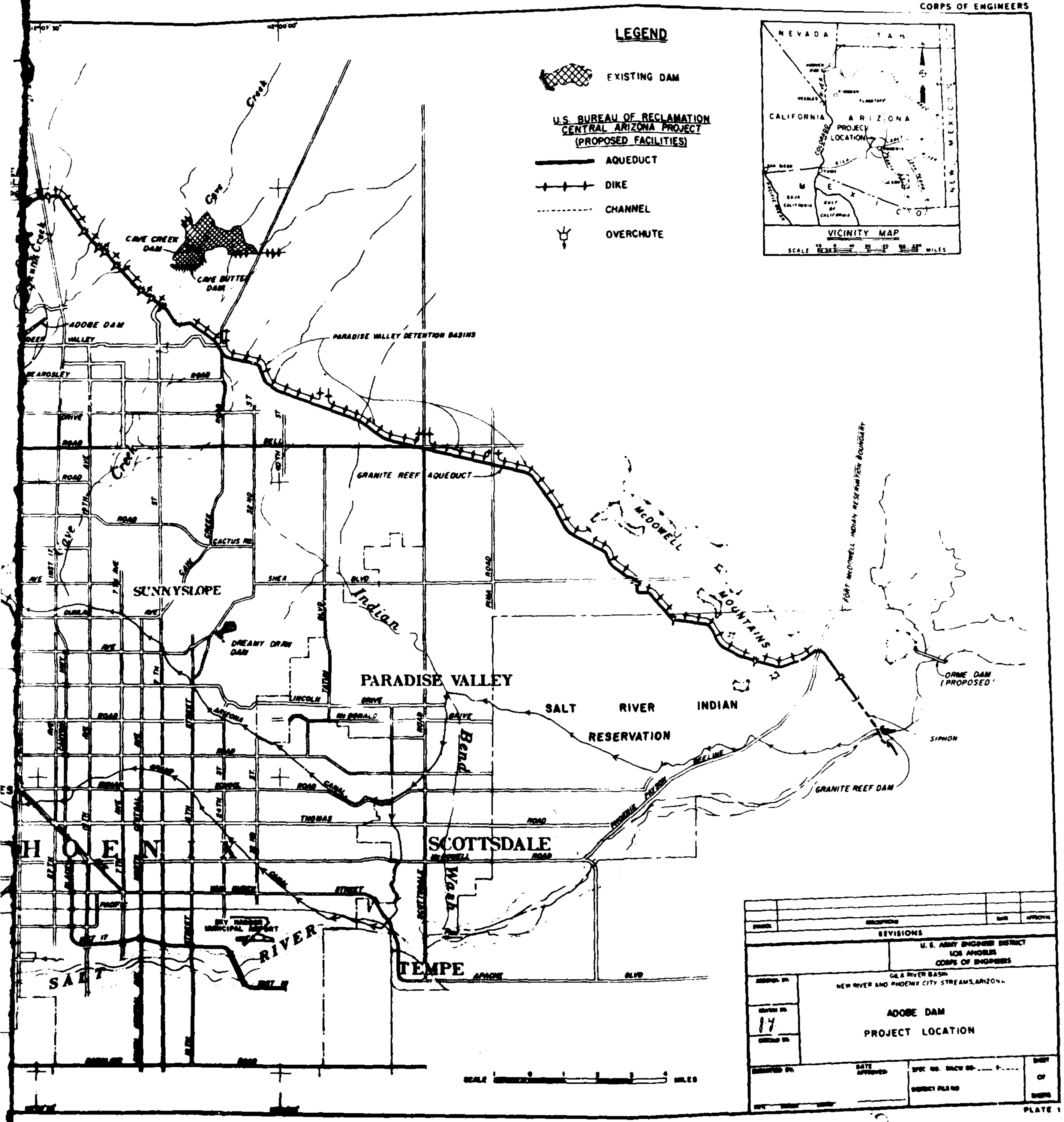
$= 217$ ft^3/day/ft

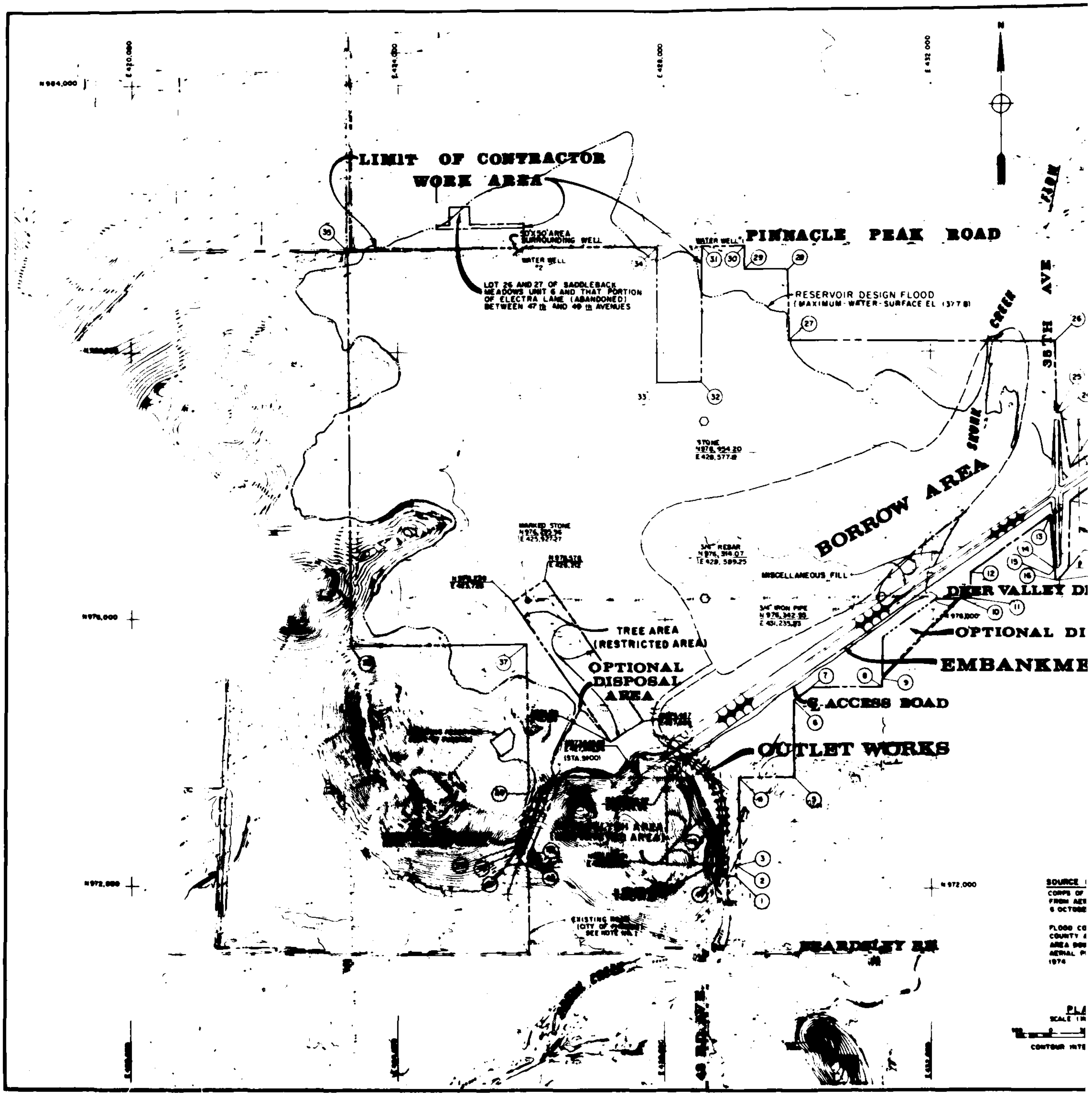
Embankment Underseepage

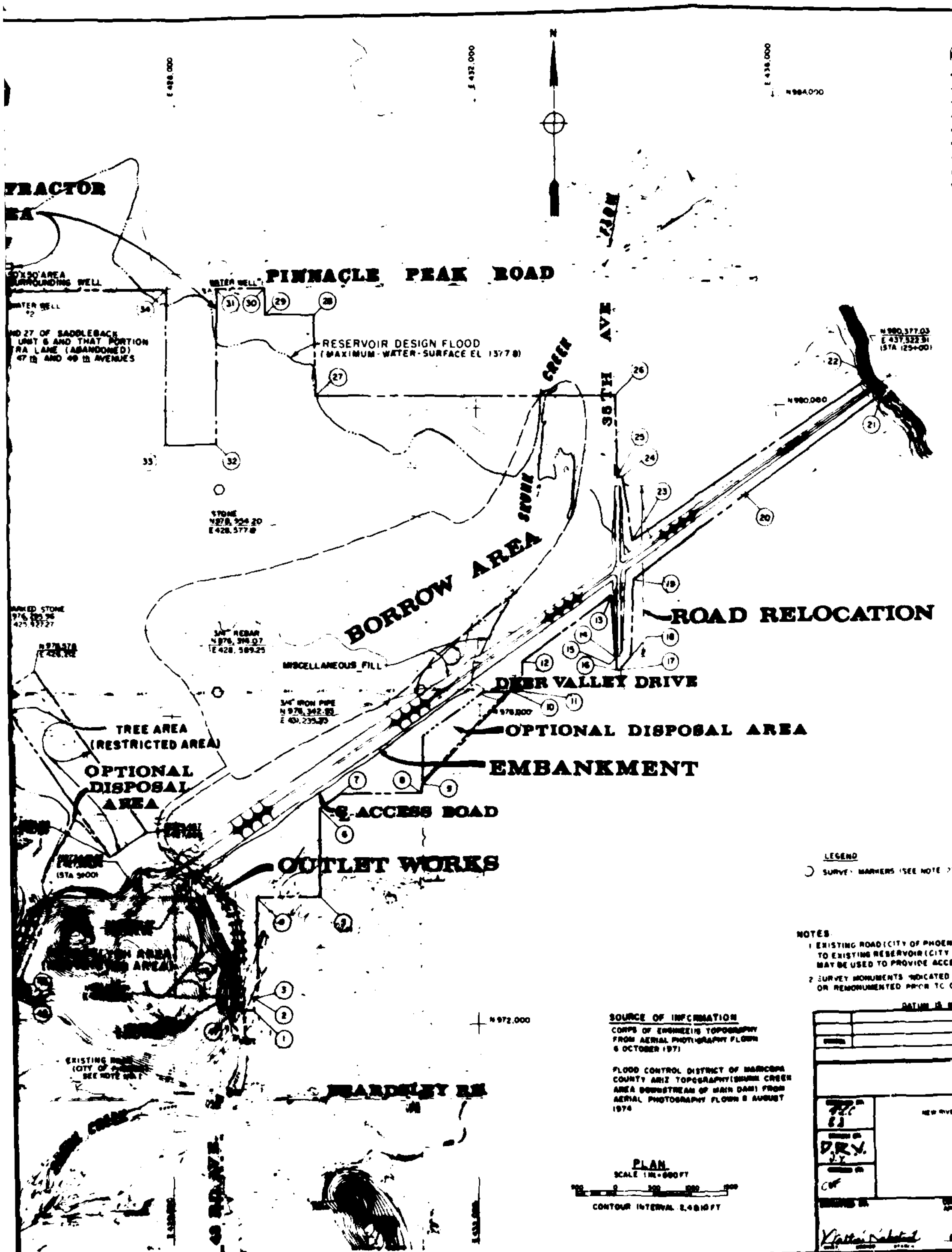
FIGURE 11

PLATES


U.S. ARMY ENGINEER DISTRICT
N
Deadman Wash
SIPHONS
River
Cave Creek
CAVE CREEK DAM
CAVE BUTTES DAM
PROJECT LOCATION
ADOBE DAM
PARADISE VALLEY DETENTION BASINS
GRANITE REEF AQUEDUCT
DIP CROSSINGS
SUN CITY
PEORIA
SUNNYSLOPE
DREAMY DRAW DAM
Indian
PARADISE VALLEY
GLENDALE
MARYVALE
ALHAMBRA
P H O E N I X
SCOTTSDALE
Bend Wash
TOLLESON
AVONDALE
SALT RIVER
TEMPE
GILA RIVER
Agua Fria
BEARDSLEY ROAD
BELL ROAD
THUNDERBIRD
OLIVE
NORTHERN
GLENDALE
BETHANY
CAMELBACK
INDIAN SCHOOL
THOMAS
McDOWELL
VAN BUREN
BUCKEYE
LOWER BUCKEYE
BROADWAY
SOUTHERN
SHEA BLVD
CACTUS RD
LITCHFIELD
CANAL
ATCHISON TOPEKA & SANTA FE
U.S. HIGHWAY 60-89 & STATE HIGHWAY 93
SKY HARBOR MUNICIPAL AIRPORT


CORPS OF ENGINEERS
LEGEND
EXISTING DAM
U.S. BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT
(PROPOSED FACILITIES)
AQUEDUCT
DIKE
CHANNEL
OVERCHUTE
NEVADA
UTAH
CALIFORNIA
ARIZONA
NEW MEXICO
MEXICO
PROJECT LOCATION
VICINITY MAP
CAVE CREEK DAM
CAVE BUTTES DAM
ADOBE DAM
Cave Creek
PARADISE VALLEY DETENTION BASINS
GRANITE REEF AQUEDUCT
McDOWELL MOUNTAINS
FORT McDOWELL INDIAN RESERVATION BOUNDARY
ORME DAM (PROPOSED)
SIPHON
GRANITE REEF DAM
SALT RIVER INDIAN RESERVATION
PARADISE VALLEY
SUNNYSLOPE
DREAMY DRAW DAM
Indian Bend Wash
SCOTTSDALE
PHOENIX
TEMPE
SALT RIVER
SKY HARBOR MUNICIPAL AIRPORT
REVISIONS
U. S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS
GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA
ADOBE DAM
PROJECT LOCATION
PLATE 1


LIMIT OF CONTRACTOR WORK AREA
PINNACLE PEAK ROAD
50'X50' AREA SURROUNDING WELL
WATER WELL #2
WATER WELL
LOT 26 AND 27 OF SADDLEBACK MEADOWS UNIT 6 AND THAT PORTION OF ELECTRA LANE (ABANDONED) BETWEEN 47 th AND 49 th AVENUES
RESERVOIR DESIGN FLOOD (MAXIMUM WATER SURFACE EL 1377.8)
35TH AVE
BORROW AREA
MISCELLANEOUS FILL
TREE AREA (RESTRICTED AREA)
OPTIONAL DISPOSAL AREA
OPTIONAL DI
EMBANKME
DEER VALLEY DR
ACCESS ROAD
OUTLET WORKS
BEARDSLEY RD
43 RD AVE
E 420,000
E 424,000
E 428,000
E 432,000
N 984,000
N 976,000
N 972,000
SOURCE
PLA



POINT NO.	NORTHING	EASTING
1	N.972,146.35	E 429,004.79
2	N.972,346.35	E 429,004.06
3	N.972,346.90	E 429,054.06
4	N.973,671.91	E 429,040.10
5	N.973,681.03	E 429,922.12
6	N.974,922.07	E 429,917.49
7	N.975,005.15	E 430,037.79
8	N.975,018.24	E 431,240.17
9	N.975,102.93	E 431,239.85
10	N.976,348.87	E 432,410.21
11	N.976,349.62	E 432,557.15
12	N.976,759.79	E 432,557.49
13	N.977,616.87	E 433,760.65
14	N.976,778.10	E 433,811.85
15	N.976,778.10	E 433,836.46
16	N.976,589.72	E 433,837.42
17	N.976,600.27	E 433,917.42
18	N.976,779.21	E 434,041.35
19	N.977,844.10	E 434,088.91
20	N.978,848.15	E 435,539.21
21	N.980,165.54	E 437,424.55
22	N.980,372.56	E 437,284.40
23	N.978,241.52	E 434,059.28
24	N.979,160.80	E 433,900.22
25	N.979,160.25	E 433,820.22
26	N.980,142.78	E 433,858.42
27	N.980,171.69	E 429,899.33
28	N.981,246.36	E 429,884.74
29	N.981,255.37	E 429,225.48
30	N.981,590.51	E 429,222.28
31	N.981,594.42	E 428,564.66
32	N.979,594.44	E 428,574.15
33	N.979,598.54	E 427,914.20
34	N.981,586.52	E 427,904.71
35	N.981,531.16	E 423,259.89
36	N.975,644.17	E 423,285.24
37	N.975,646.20	E 425,831.98
38	N.973,383.59	E 425,981.75
39	N.972,608.09	E 425,758.64
40	N.972,498.10	E 425,759.61
41	N.972,338.67	E 425,631.00
42	N.972,339.59	E 425,434.00
43	N.972,400.63	E 425,960.61
44	N.973,680.87	E 426,409.41
45	N.973,666.04	E 428,395.09
46	N.972,801.42	E 428,771.73
47	N.972,144.17	E 428,804.81

COORDINATES FOR LIMIT OF CONTRACTOR WORK AREA
(T.M. CENTRAL)

LEGEND

SURVEY MARKERS (SEE NOTE 2)

NOTES

1 EXISTING ROAD (CITY OF PHOENIX) TO EXISTING RESERVOIR (CITY OF PHOENIX) MAY BE USED TO PROVIDE ACCESS TO SPILLWAY

2 SURVEY MONUMENTS INDICATED ARE TO BE PROTECTED IN PLACE OR REMONUMENTED PRIOR TO COMPLETION OF CONTRACT

DATUM IS MEAN SEA LEVEL

REVISIONS

U.S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA

ADOBE DAM
GENERAL PLAN

D.R.Y.

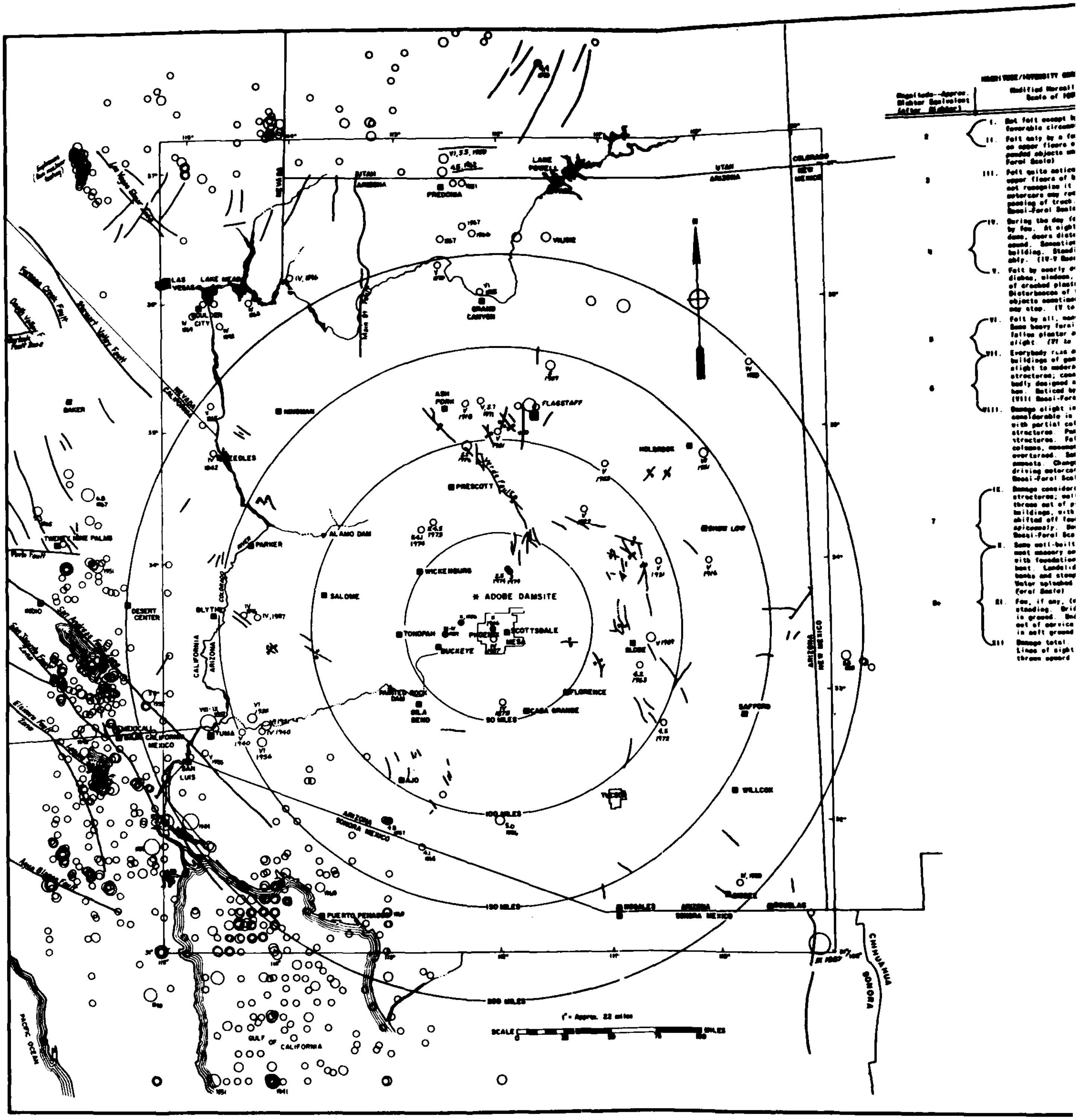
DATE APPROVED

AUG 1980

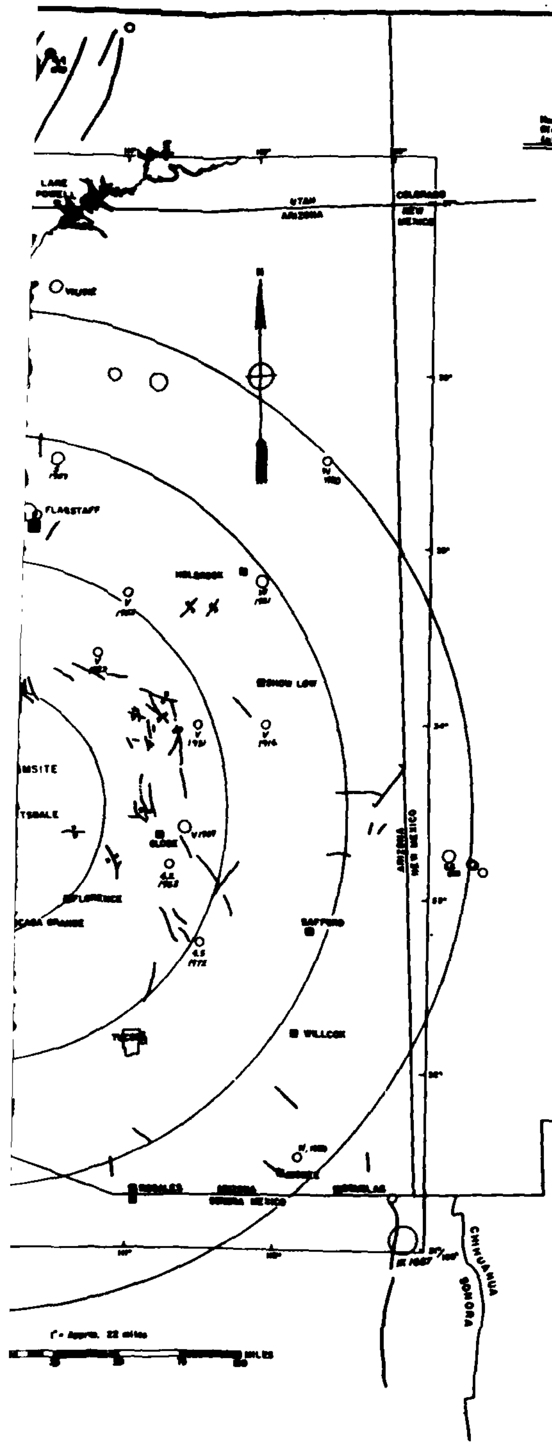
HSTRI FILE NO 292/2

SHEET 2 OF 72 SHEETS

PLATE 2



ADOBE DAMSITE
PHOENIX
SCOTTSDALE
MESA
BUCKEYE
TONOPAH
WICKENBURG
PRESCOTT
ASH FORK
FLAGSTAFF
HOLBROOK
SHOW LOW
GLOBE
FLORENCE
CASA GRANDE
SAFFORD
WILLCOX
NOGALES
DOUGLAS
AJO
GILA BEND
PAINTED ROCK DAM
YUMA
SAN LUIS
BLYTHE
PARKER
ALAMO DAM
SALOME
NEEDLES
KINGMAN
BAKER
LAS VEGAS
LAKE MEAD
BOULDER CITY
GRAND CANYON
FREDONIA
LAKE POWELL
DESERT CENTER
INDIO
TWENTY NINE PALMS
PUERTO PENASCO
50 MILES
100 MILES
150 MILES
200 MILES
UTAH
ARIZONA
NEVADA
CALIFORNIA
NEW MEXICO
COLORADO
SONORA MEXICO
CHIHUAHUA
SONORA
GULF OF CALIFORNIA
PACIFIC OCEAN
1" = Approx. 22 miles
SCALE
MILES



MAGNITUDE/INTENSITY CHART

Magnitude--Approx. Richter Equivalent (after Richter)		Modified Mercalli Intensity (damage) Scale of 1931 (abridged)
2	I.	Not felt except by a very few under especially favorable circumstances. (I Rossi-Forel Scale)
	II.	Felt only by a few persons at rest, especially on upper floors of buildings. Delicately suspended objects may swing. (I to II Rossi-Forel Scale)
3	III.	Felt quite noticeably indoors, especially on upper floors of buildings, but many people do not recognize it as an earthquake. Standing motorcars may rock slightly. Vibration like passing of truck. Duration estimated. (III Rossi-Forel Scale)
4	IV.	During the day felt indoors by many, outdoors by few. At night some awakened. Dishes, windows, doors disturbed; walls make creaking sound. Sensation like heavy truck striking building. Standing motorcars rocked noticeably. (IV-V Rossi-Forel Scale)
	V.	Felt by nearly everyone, many awakened. Some dishes, windows, etc., broken; a few instances of cracked plaster; unstable objects overturned. Disturbances of trees, poles, and other tall objects sometimes noticed. Pendulum clocks may stop. (V to VI Rossi-Forel Scale)
5	VI.	Felt by all, many frightened and run outdoors. Some heavy furniture moved; a few instances of fallen plaster or damaged chimneys. Damage slight. (VI to VII Rossi-Forel Scale)
6	VII.	Everybody runs outdoors. Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable in poorly built or badly designed structures; some chimneys broken. Noticed by persons driving motorcars. (VIII Rossi-Forel Scale)
	VIII.	Damage slight in specially designed structures, considerable in ordinary substantial buildings with partial collapse; great in poorly built structures. Panel walls thrown out of frame structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. Sand and mud ejected in small amounts. Changes in well water. Persons driving motorcars disturbed. (VIII+ to IX Rossi-Forel Scale)
7	IX.	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb; great in substantial buildings, with partial collapse. Buildings shifted off foundations. Ground cracked conspicuously. Underground pipes broken. (IX+ Rossi-Forel Scale)
8+	X.	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations; ground badly cracked. Rails bent. Landslides considerable from river banks and steep slopes. Shifted sand and mud. Water splashed (slopped) over banks. (X Rossi-Forel Scale)
	XI.	Few, if any, (masonry) structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipelines completely out of service. Earth slumps and land slips in soft ground. Rails bent greatly.
	XII.	Damage total. Waves seen on ground surface. Lines of sight and level distorted. Objects thrown upward into the air.

LEGEND

- V 1918 — Earthquake epicenter, giving intensity (from Modified Mercalli Scale of 1931) in Roman numerals, and year of quake. Where no intensity is given, it is not known.
- 4.1 1963 — Earthquake of known magnitude, according to the Richter Scale.
- ● — Location and intensities (south east method), from Palo Verde Nuclear Generating Station Report, Arizona Public Service Co. 1975
- IV 4.5 1966 — Earthquake of known magnitude and intensity
- EH 5 1973 — Artificial shock caused by mining activities
- M<4.0; 4.0≤M<5.0; 5.0≤M<6.0; 6.0≤M<7.0; 7.0≤M<8.0; 8.0≤M — Magnitude of shock determined by size of circle
- Town or city
- Larger city
- Quaternary fault traces, dashed where approximately located, dotted where concealed. Sawteeth on upper plate of thrust(?)
  - U — Upthrown side
  - D — Downthrown side
- * — Location of Adobe damsite

GENERAL NOTES

1. Richter Scale magnitudes are a measure of the energy release at the focus (center of the earthquake), as determined by the amplitudes produced on a seismogram. Epicenter is the point on the Earth's surface directly above the focus.
2. Intensity, expressed on the Modified Mercalli Intensity Scale of 1931, is a measure of the effects of an earthquake on people and objects, as determined by experienced observers. (See chart this sheet. Approximate equivalents of intensity and magnitude are shown.) Intensities on this sheet are recorded at the epicenters.
3. Earthquake information gathered from U.S. Dept. of Commerce publication, United States Earthquakes (1938 through 1971), and from U.S. Dept. of Commerce Environmental Data Service, Boulder, Colorado.
4. Map of Arizona drawn using Richfield Oil Company map of 1962 and Arizona Highway Dept. map of 1970.
5. Rossi-Forel Scale shown in chart is still used by some countries to evaluate earthquake effects.
6. Center of Phoenix is used as focal center of mileage rings.
7. Longest Quaternary fault within 100 miles of Phoenix is 33 miles long.
8. Only earthquakes greater than 4 magnitude are shown outside of the 150-mile radius circle.
9. Earthquake of Dec. 30, 1934 in Mexico: intensity felt in the vicinity of Phoenix was reported as III.
   Earthquake of May 18, 1940 near Imperial, Calif.: intensity felt in the vicinity of Phoenix was reported at about IV.
   Earthquake of Apr. 10, 1947 near Barstow (VIII): intensity felt in vicinity of Phoenix was IV.
   The 1887(8) Sonora earthquake apparently was only felt by a few persons (i.e. <III) in Phoenix area.
   Prior to 1974, 5 earthquakes were reportedly felt at Phoenix (i.e. 1903, 1906 (2), 1934 and 1937). These have no instrumentally located epicenters within Arizona. Of six events felt in Phoenix, two have epicenters in Baja and one near Flagstaff. (Sturgul and Irwin, 1971)

SYMBOL	DESCRIPTION	DATE	APPROVAL

REVISIONS

U. S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA

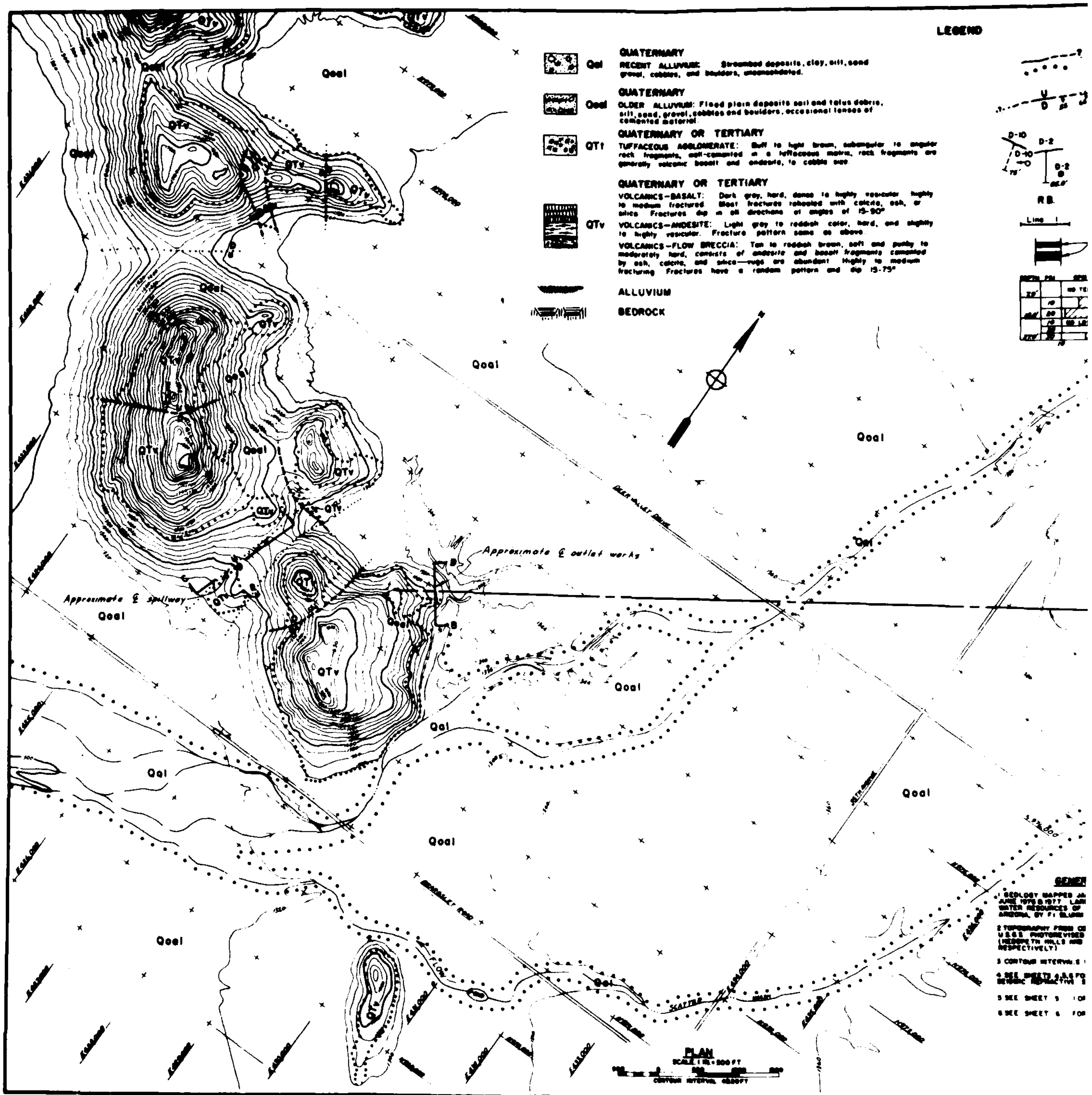
ADOBE DAM

STRUCTURAL FEATURES AND LOCATIONS OF EARTHQUAKE EPICENTERS IN ARIZONA

DESIGNED BY: R.M.H.
DRAWN BY: A.R.P.
CHECKED BY: [illegible]

2

PLATE 3


LEGEND
QUATERNARY
Qal
RECENT ALLUVIUM: Streambed deposits, clay, silt, sand gravel, cobbles, and boulders, unconsolidated.
QUATERNARY
Qoal
OLDER ALLUVIUM: Flood plain deposits soil and talus debris, silt, sand, gravel, cobbles and boulders, occasional lenses of cemented material.
QUATERNARY OR TERTIARY
QTt
TUFFACEOUS AGGLOMERATE: Buff to light brown, subangular to angular rock fragments, well-cemented in a tuffaceous matrix, rock fragments are generally volcanic basalt and andesite, to cobble size.
QUATERNARY OR TERTIARY
QTv
VOLCANICS—BASALT: Dark gray, hard, dense to highly vesicular. Highly to medium fractured. Most fractures rehealed with calcite, ash, or silica. Fractures dip in all directions at angles of 15-90°
VOLCANICS—ANDESITE: Light gray to reddish color, hard, and slightly to highly vesicular. Fracture pattern same as above.
VOLCANICS—FLOW BRECCIA: Tan to reddish brown, soft and punky to moderately hard, consists of andesite and basalt fragments cemented by ash, calcite, and silica—vugs are abundant. Highly to medium fracturing. Fractures have a random pattern and dip 15-75°
ALLUVIUM
BEDROCK
Qoal
QTv
Qal
Approximate ℄ outlet works
Approximate ℄ spillway
R.B.
PLAN
SCALE 1 IN. = 500 FT

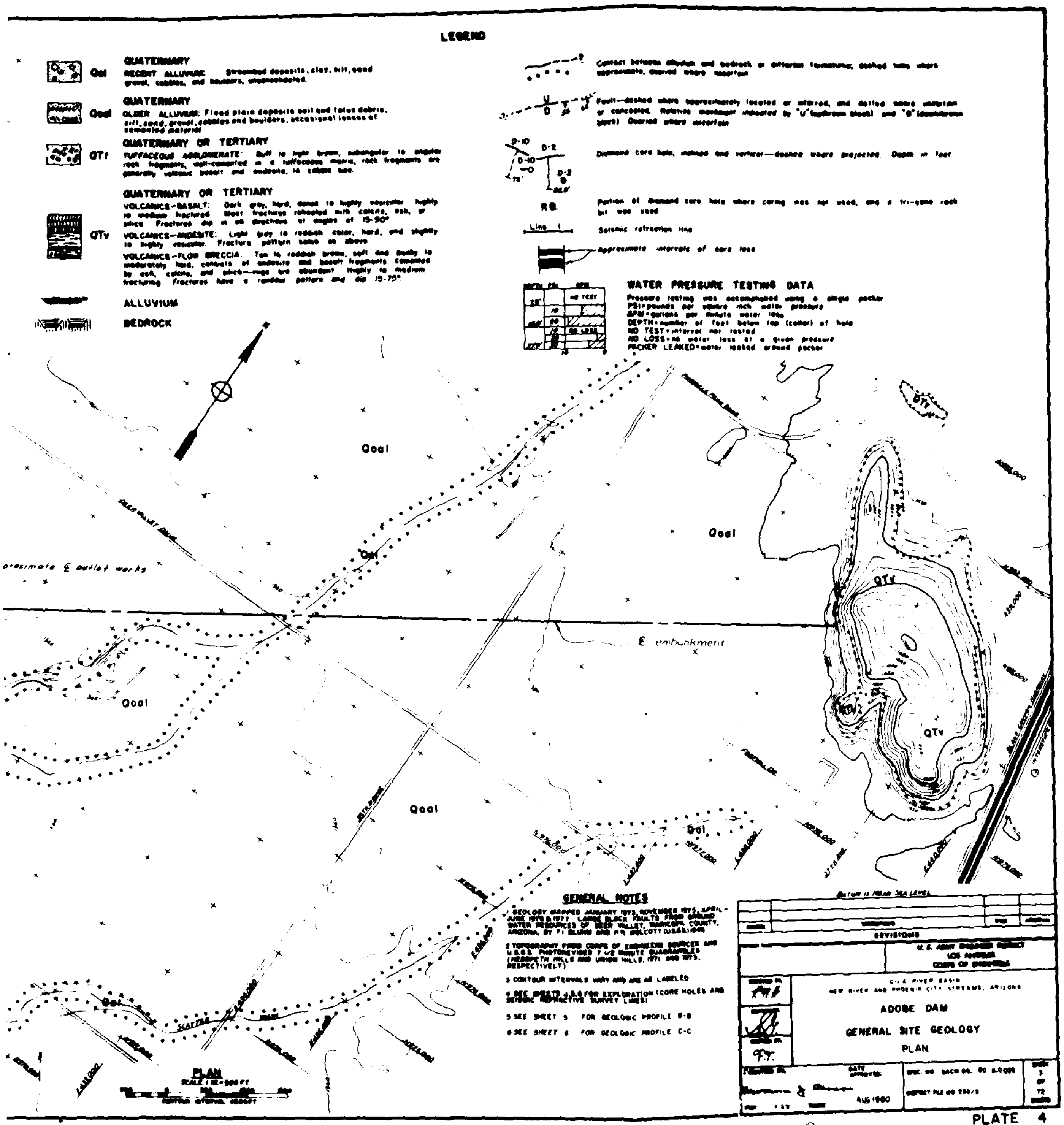
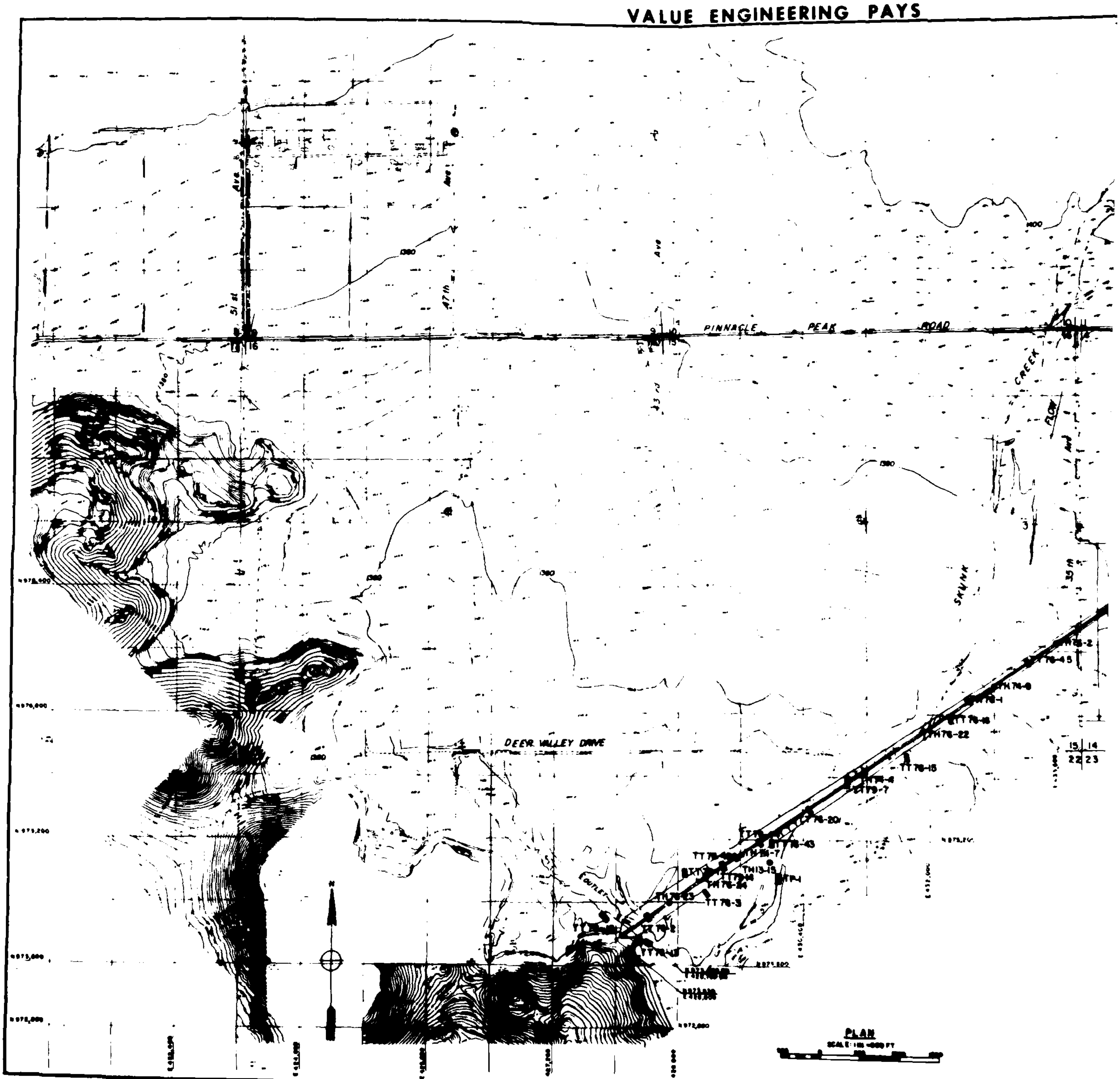
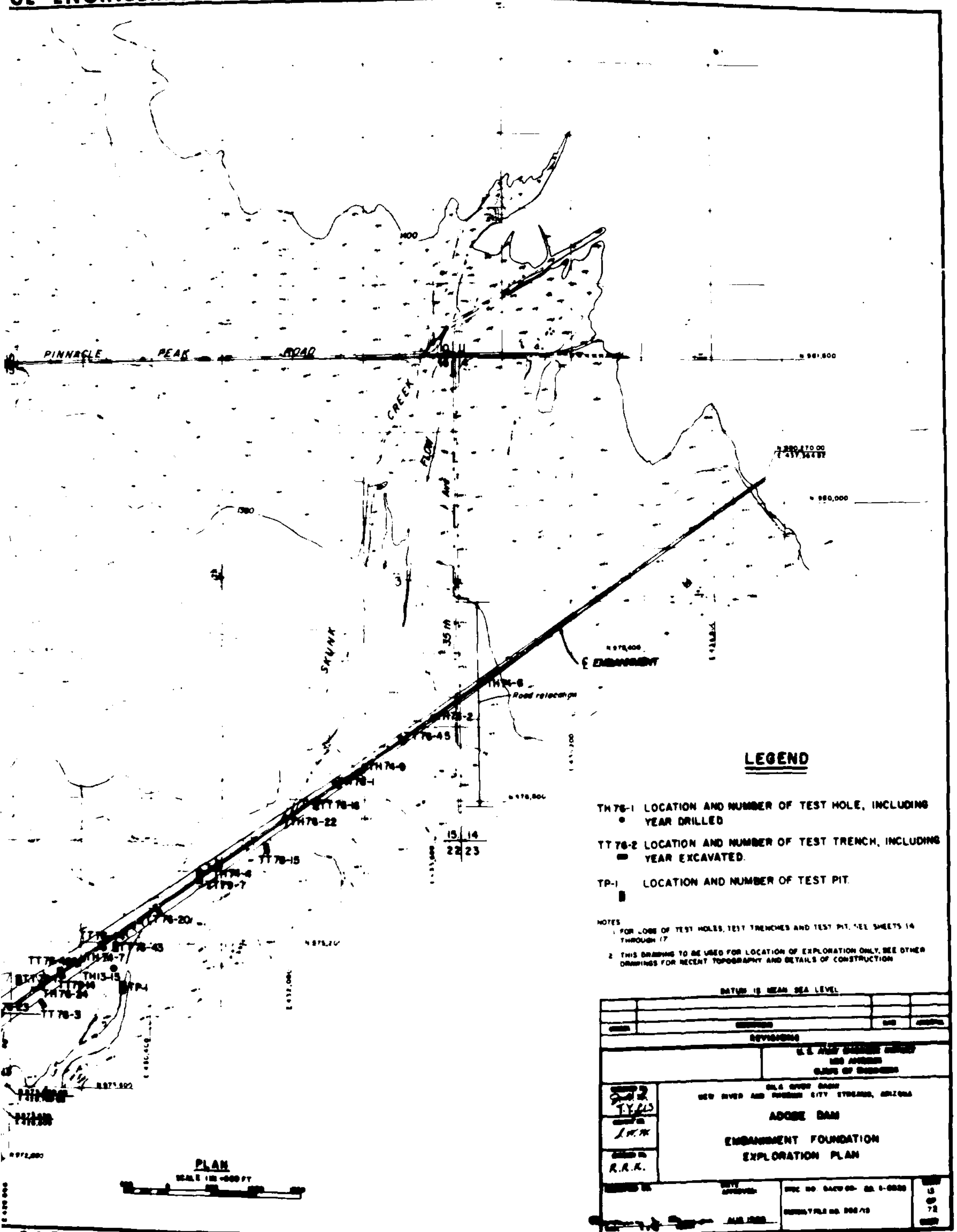

LEGEND
QUATERNARY
Qal RECENT ALLUVIUM: Streambed deposits, clay, silt, sand gravel, cobbles, and boulders, unconsolidated.
QUATERNARY
Qoal OLDER ALLUVIUM: Flood plain deposits soil and talus debris, silt, sand, gravel, cobbles and boulders, occasional lenses of cemented material
QUATERNARY OR TERTIARY
QTt TUFFACEOUS AGGLOMERATE
QUATERNARY OR TERTIARY
QTv VOLCANICS–BASALT: Dark gray, hard, dense to highly vesicular. Fractures dip in all directions at angles of 15-90°
VOLCANICS–ANDESITE: Light gray to reddish color, hard, and slightly to highly vesicular. Fracture pattern same as above
VOLCANICS–FLOW BRECCIA
ALLUVIUM
BEDROCK
Diamond core hole, inclined and vertical—dashed where projected. Depth in feet
R.B.
Seismic refraction line
Approximate intervals of core loss
WATER PRESSURE TESTING DATA
PSI=pounds per square inch water pressure
DEPTH=number of feet below top (collar) of hole
NO TEST=interval not tested
NO LOSS=no water loss at a given pressure
PACKER LEAKED=water leaked around packer
Qoal
Qal
QTv
£ embankment
PLAN
CONTOUR INTERVAL
GENERAL NOTES
3 CONTOUR INTERVALS VARY AND ARE AS LABELED
5 SEE SHEET 5 FOR GEOLOGIC PROFILE B-B
6 SEE SHEET 6 FOR GEOLOGIC PROFILE C-C
DATUM IS MEAN SEA LEVEL
REVISIONS
GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA
ADOBE DAM
GENERAL SITE GEOLOGY
PLAN
AUG 1980

PLATE 4


PINNACLE PEAK ROAD
DEER VALLEY DRIVE
CREEK
FLOW
SKUNK
OUTLET
51 st Ave
47 th Ave
43 rd Ave
35 th Ave
PLAN

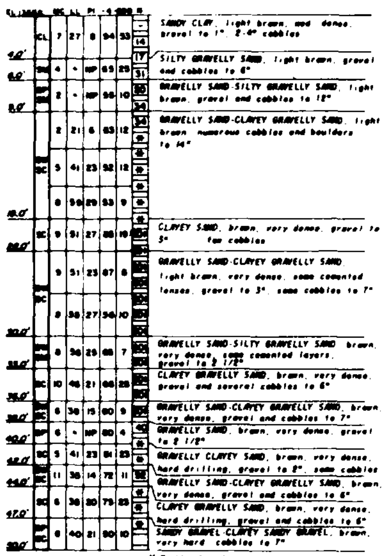
UE ENGINEERING PAYS



SAFETY PAYS

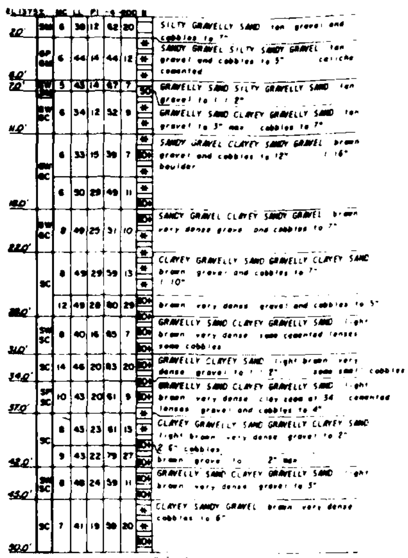
PLATE 5

T.H. 76-1



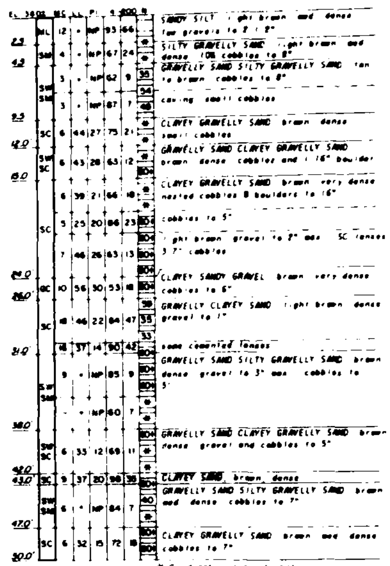
* Could not seat penetrometer

T.H. 76-2



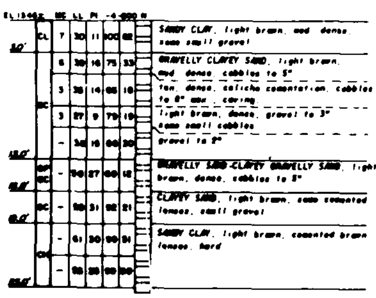
* Could not seat penetrometer

T.H. 76-22



* Could not seat penetrometer

T.H. 76-24



UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GROUP SYMBOLS	TYPICAL NAMES
COARSE GRAINED SOILS (More than half of material is larger than No. 200 sieve size)	GRAVELS (More than half of coarse fraction is larger than No. 4 sieve size)	Clean gravels	GW	Well-graded gravels, gravel-sand mixtures, little or no fines.
			GP	Poorly-graded gravels, gravel-sand mixtures, little or no fines.
		Gravels with fines	GM	Silty gravels, gravel-sand-silt mixtures.
			GC	Clayey gravels, gravel-sand-clay mixtures.
	SANDS (More than half of coarse fraction is smaller than No. 4 sieve size)	Clean sands	SW	Well-graded sands, gravelly sands, little or no fines.
			SP	Poorly-graded sands, gravelly sands, little or no fines.
		Sands with fines	SM	Silty sands, sand-silt mixtures.
			SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS (More than half of material is smaller than No. 200 sieve size)	SILTS AND CLAYS	Low liquid limit	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts, with slight plasticity.
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
			OL	Organic silts and organic silty clays of low plasticity.
		High liquid limit	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
			CH	Inorganic clays of high plasticity, fat clays.
			OH	Organic clays of medium to high plasticity, organic silts.
Highly organic soils			Pt	Peat and other highly organic soils.

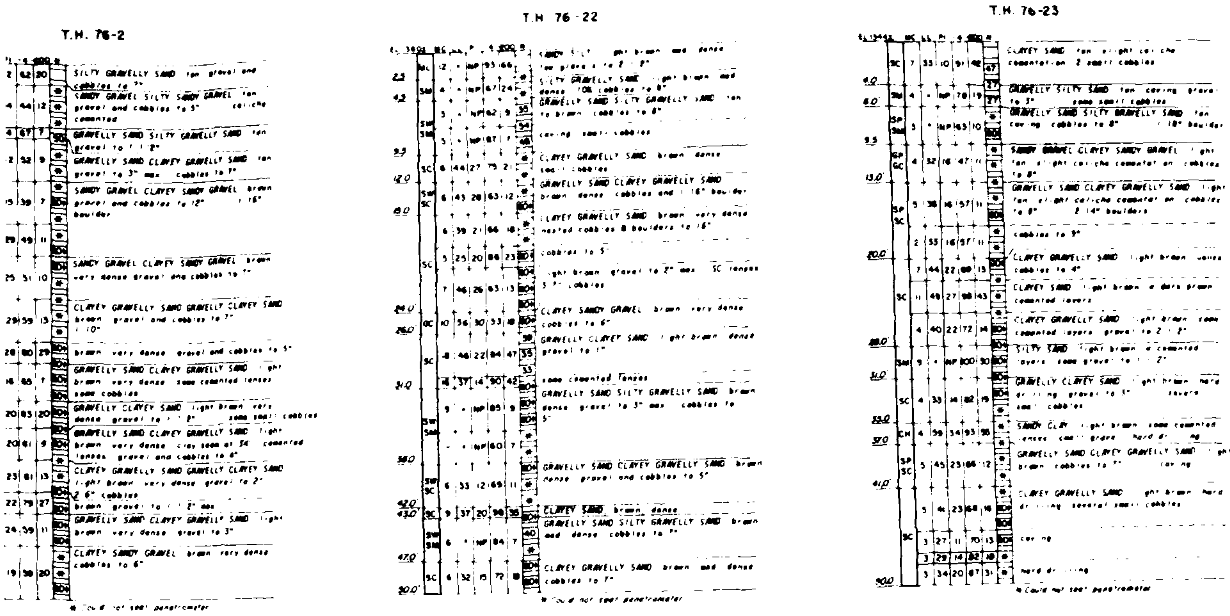
NOTES:

1. Boundary Classification. Soils possessing characteristics of two groups are designated by combinations of group symbols. For example, GW-GC, well-graded gravel-sand mixture with clay binder.
2. All sieve sizes on this chart are U. S. Standard.
3. The terms "silt" and "clay" are used respectively to distinguish materials exhibiting lower plasticity from those with higher plasticity. The minus no. 200 sieve material is silt if the liquid limit and plasticity index plot below the "A" line on the plasticity chart (Table VI, Military Standard 619B) and is clay if the liquid limit and plasticity index plot above the "A" line on the chart.
4. For a complete description of the Unified Soil Classification System, see Military Standard 619B dated 20 March 1970.
5. The term cobble refers to rocks larger than 3 inches but smaller than 12 inches in the minimum dimension. The term boulder refer to rock larger than 12 inches in the minimum dimension.

VERT. SCALE 0 5 10 15 FEET

LEGEND

- T.H. 76-2 NUMBER OF TEST HOLE AND YEAR EXCAVATED
- T.T. 76-17 NUMBER OF TEST TRENCH AND YEAR EXCAVATED.
- T.P. 2 NUMBER OF TEST PIT.
- MC FIELD MOISTURE CONTENT IN PERCENT OF DRY WEIGHT.
- LL LIQUID LIMIT., o INDICATES TESTED.
- PI PLASTICITY INDEX (LIQUID LIMIT MINUS PLASTIC LIMIT)
- NP NONPLASTIC
- -4 PERCENT OF MATERIAL BY WEIGHT PASSING NO. 4 SIEVE.
- -200 PERCENT OF MATERIAL BY WEIGHT PASSING NO. 200 SIEVE.
- N NUMBER OF BLOWS OF A 140-POUND DRIVEHAMMER FALLING 30 INCHES REQUIRED TO DRIVE A SAMPLING SPOON ONE FOOT. OUTSIDE DIAMETER OF SPOON IS 2 INCHES. INSIDE DIAMETER IS 1-3/8 INCHES. PROCEDURE IS CALLED STANDARD PENETRATION TEST.



UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GROUP SYMBOLS	TYPICAL NAMES
COARSE GRAINED SOILS	GRAVELS	Clean gravels	GW	Well-graded gravels, gravel-sand mixtures, little or no fines.
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines.
		Gravels with fines	GM	Silty gravels, gravel-sand-silt mixtures.
			GC	Clayey gravels, gravel-sand-clay mixtures.
	SANDS	Clean sands	SW	Well-graded sands, gravelly sands, little or no fines.
			SP	Poorly graded sands, gravelly sands, little or no fines.
		Sands with fines	SM	Silty sands, sand-silt mixtures.
			SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS	SILTS AND CLAYS	Low liquid limit	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts, with slight plasticity.
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
			OL	Organic silts and organic silty clays of low plasticity.
		High liquid limit	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
			CH	Inorganic clays of high plasticity, fat clays.
			OH	Organic clays of medium to high plasticity, organic silts.
Highly organic soils			Pt	Peat and other highly organic soils.

NOTES:

1. Boundary Classification. Soils possessing characteristics of two groups are designated by combinations of group symbols. For example, GW-GC, well-graded gravel-sand mixture with clay binder.
2. All sieve sizes on this chart are U. S. Standard.
3. The terms "silt" and "clay" are used respectively to distinguish materials exhibiting lower plasticity from those with higher plasticity. The minus no. 200 sieve material is silt if the liquid limit and plasticity index plot below the "A" line on the plasticity chart (Table VI, Military Standard 619B) and is clay if the liquid limit and plasticity index plot above the "A" line on the chart.
4. For a complete description of the Unified Soil Classification System, see Military Standard 619B dated 29 March 1976.
5. The term cobble refers to rocks larger than 3 inches but smaller than 12 inches in the minimum dimension. The term boulder refers to rock larger than 12 inches in the minimum dimension.

GENERAL NOTES

1. SEE SHEET 3 FOR LOCATION OF TEST HOLES, TEST TRENCHES AND TEST PITS
2. SEE THIS SHEET FOR NOTES, LEGEND AND BASIS FOR CLASSIFICATION
3. TEST HOLES ON THIS SHEET WERE DRILLED IN FEB TO APRIL 1976 WITH A 16 INCH OR 24 INCH DIAMETER BUCKET TYPE POWER AUGER
4. PERCENTAGES OF COBBLES AND BOULDERS WHERE INDICATED WERE ESTIMATED BY VISUAL OBSERVATION
5. GRADATION AND PERCENTAGES OF -#4 AND -#200 ARE REPRESENTATIVE OF -3 INCH MATERIAL
6. TEST HOLES WERE DRILLED WITH A 16 OR 24 INCH DIAMETER BUCKET TYPE POWER AUGER IN OCTOBER 1974 AND APRIL TO MAY 1976
7. TEST TRENCHES WERE EXCAVATED WITH A BACKHOE IN MAY 1976, JUNE 1978 AND MAY 1979
8. TEST PITS WERE EXISTING EXCAVATIONS

LEGEND

T.H.	76-2 NUMBER OF TEST HOLE AND YEAR EXCAVATED
T.T.	76-17 NUMBER OF TEST TRENCH AND YEAR EXCAVATED
T.P.	2 NUMBER OF TEST PIT
MC	FIELD MOISTURE CONTENT IN PERCENT OF DRY WEIGHT
LL	LIQUID LIMIT, ☉ INDICATES TESTED
PI	PLASTICITY INDEX (LIQUID LIMIT MINUS PLASTIC LIMIT)
NP	NONPLASTIC
-4	PERCENT OF MATERIAL BY WEIGHT PASSING NO. 4 SIEVE
-200	PERCENT OF MATERIAL BY WEIGHT PASSING NO. 200 SIEVE
B	NUMBER OF BLOWS OF A 140-POUND DROPHAMMER FALLING 30 INCHES REQUIRED TO DRIVE A SAMPLING SPOON ONE FOOT. OUTSIDE DIAMETER OF SPOON IS 2 INCHES, INSIDE DIAMETER IS 1 3/8 INCHES. PROCEDURE IS CALLED STANDARD PENETRATION TEST

VERT. SCALE 0 5 10 15 FEET

REVISIONS

U.S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA

ADOBE DAM
EMBANKMENT FOUNDATION
SOIL LOGS

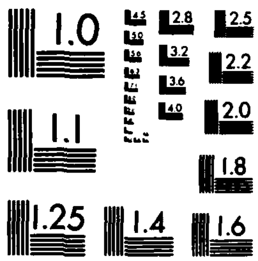
DESIGNED BY: LCS
DRAWN BY: ///
CHECKED BY: TY
SUBMITTED BY:
DATE APPROVED AUG 1980
SPEC NO. DACW09- 80- B-0085
DISTRICT FILE NO. 282/14
SHEET 4 OF 7

PLATE 6

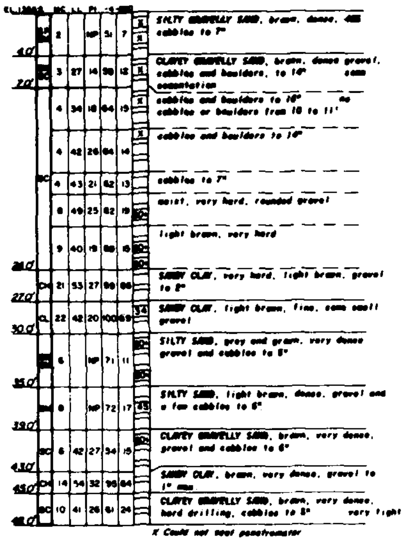
AD-A169 825 EMBANKMENT CRITERIA AND PERFORMANCE REPORT: ADOBE DAM GILA RIVER BASIN NEW RIVER AND PHOENIX CITY STREAMS ARIZONA(U) ARMY ENGINEER DISTRICT LOS ANGELES CA 2/2

UNCLASSIFIED JUN 83 F/G 13/13 NL

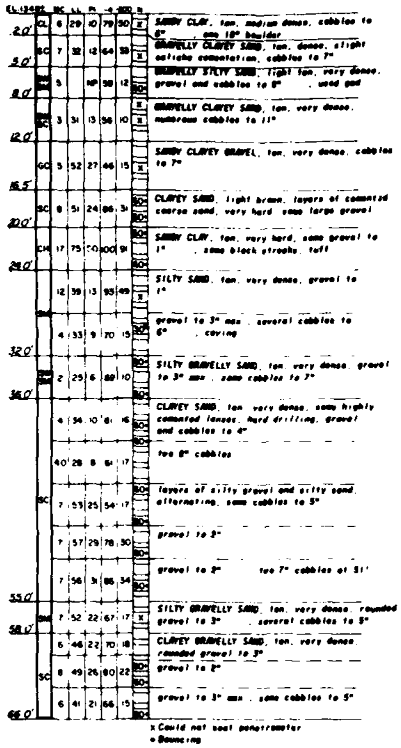
END


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0

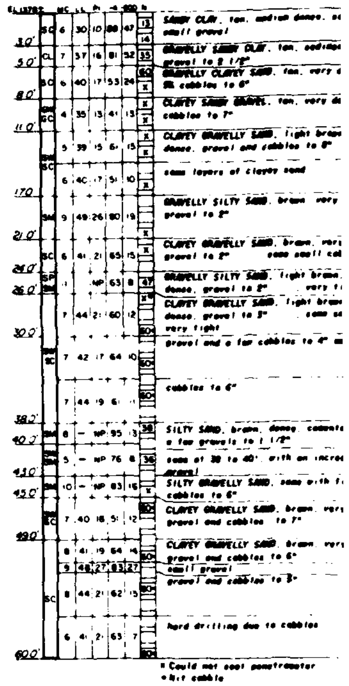
TH 74-4



TH 74-7



T.H. 74-8



VERT. SCALE FEET

NOTES

1. SEE SHEET 15 FOR LOCATION OF TEST HOLES AND TEST TRENCHES
2. SEE SHEET 16 FOR GENERAL NOTES LEGEND AND BASIS FOR CLASSIFICATION
3. TEST HOLES ON THIS SHEET WERE DRILLED IN OCT. 1974 WITH A 18 INCH OR 24 INCH DIAMETER BUCKET TYPE POWER AUGER

VERT. SCALE FEET

REVISIONS

U.S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA

ADOBE DAM
EMBANKMENT FOUNDATION
SOIL LOGS

LCS
D.R.V.
TY

2

AUG 1980

DISTRICT FILE NO. 262/15

PLATE 7

T.T. 76-1

MC LL PI -4 -200 II

SILTY SAND, light brown, some small gravel
caliche, plastic, gravel to 1"

SANDY SILTY GRAVEL, grey, coarse grained, loose, gravel to 1"

SANDY GRAVEL, grey, welded sand, some gravel to 2"

GRAVELLY SAND, grey, loose, gravel and cobbles to 8"

SILTY SANDY GRAVEL, tan, hard tuff

T.T. 76-2

SANDY CLAY, brown to light brown, hard, some roots

CLAYEY SANDY GRAVEL, brown, dense, gravel and cobbles and boulders to 12"

GRAVELLY SAND-CLAYEY GRAVELLY SAND, brown and dense, some cobbles to 6", SP lenses, thin caliche lenses at 6'

SILTY SAND, light brown, caliche, cemented cobbles to 12"

GRAVELLY SAND, brown, some cementation, gravel to 3", some cobbles

SANDY GRAVEL-SILTY SANDY GRAVEL, tan, tuff, some cemented sand lens, cobble layer about 13'

* +4 — cemented materials

T.T. 76-3

SANDY CLAY, light brown, and stiff, dry
light brown, hard, cemented, some gravel to 1"

SILTY GRAVELLY SAND, brownish white, very hard, cemented, some cobbles to 8"

GRAVELLY SAND-SILTY GRAVELLY SAND, light brown, very dense, cobbles & boulders to 14" (30%), gravel to 3"

ABANDONED DUE TO COBBLES AND BOULDERS

T.T. 76-12

CLAY, grey brown, some organic, plastic.

SANDY CLAY, brown, rounded cobbles and boulders, some roots, some caliche and hard clay, boulders to 18"
same, more cobbles and boulders

SANDY CLAYEY GRAVEL, brown, same as above, 5-15% row gravel, cobbles and boulders to 20", cemented/hard below 9 1/2', plastic, some roots

ABANDONED DUE TO CEMENTATION

T.T. 76-13

SANDY SILT, light brown, plastic, some cobbles and lenses

SANDY CLAYEY GRAVEL, light brown, cemented, rounded gravel, boulders to 18", 1-4' x 2' x 1 1/2' , very hard at 4'

CLAYEY SANDY GRAVEL, light brown, well cemented, boulders to 24", extremely hard

ABANDONED DUE TO CEMENTATION AND COBBLES BOULDERS

T.T. 76-16

GRAVELLY SAND, grey, loose cobbles to 6"

GRAVELLY CLAYEY SAND, brown, cemented, some gravel to 2"

SANDY GRAVEL-CLAYEY SANDY GRAVEL, brown, cemented, gravel to 1"

GRAVELLY SAND-CLAYEY GRAVELLY SAND, same, with 60% cobbles to 8"

GRAVELLY CLAYEY SAND, brown, cemented, gravel to 8"

T.T. 76-16

MC LL PI -4 -200 II

SILTY SAND, tan, some roots

SILTY SANDY GRAVEL, tan, gravel to 2"

SANDY GRAVEL-SILTY SANDY GRAVEL, tan, very loose, caving, gravel to 3", cobbles to 8" (30%)

SANDY GRAVEL, brown, more plastic, stable sides, some gravel/cobble as above

SANDY GRAVEL-CLAYEY SANDY GRAVEL, brown, gravel to 2", some 6" cobbles (10%)

T.T.76-20

MC LL PI -4 -200 II

SILTY SAND, tan, loose, gravel & sand 1 1/2 2', gravel to 2" max, 2-8" cobbles

SANDY SILT, light brown, loose, dark streaks

SILTY SANDY GRAVEL, brown, cemented, hard, 40% cobbles and boulders to 18"

SILTY GRAVELLY SAND, red-brown, highly cemented, 20% cobbles to 9"

SILTY SANDY GRAVEL, same as above

VERT. SCALE FEET

T.T. 76-42

EL.1348± MC LL PI -4 -200 II

		MC	LL	PI	-4	-200
	CL	–	13	12	100	70
3.5'	GP GM	–	•	NP	37	8
6.0'	SW SM	–	•	NP	85	9
		–	•	NP	64	8
13.0'	SP SC	–	•	NP	76	11
14.0'	SM	–	•	NP	66	16
18.5'		–	•	NP	85	14
23.0'	ML	–	56	25	86	51

SANDY CLAY, light brown, loose to med dense, some gravel, some caliche 3.3.5'

SANDY GRAVEL-SILTY SANDY GRAVEL, tan caliche, cemented, 5% cobbles to 6"

GRAVELLY SAND-SILTY GRAVELLY SAND, grey, some cemented zones, some loose SP zones 5% cobbles to 6"
light brown & grey, some caving zones some cobbles to 6"

GRAVELLY SAND-SILTY GRAVELLY SAND, red-brown, cemented, gravel to 3", hard

SILTY GRAVELLY SAND, red-brown, cemented 15% cobbles to 12"
red-brown, cemented, gravel to 2"

GRAVELLY SANDY SILT, tan, w/black, very hard tuff

T.T. 76-43

EL.1390± MC LL PI -4 -200 II

		MC	LL	PI	-4	-200
2.5'	SC	–	33	13	84	45
6.0'	SP SM	–	•	NP	85	11
8.0'	SW SM	–	•	NP	64	11
12.0'	SM		47	14	70	14

CLAYEY SILTY GRAVEL, light brown to tan, loose, slight cementation 2'-2.5', some gravel to 2"

GRAVELLY SAND-SILTY GRAVELLY SAND, grey, lenses of sand & gravelly sand, loose, 20% cobbles to 10"
red-brown, hard & cemented, some gravel to

SILTY GRAVELLY SAND, red-brown, hard cemented 20% cobbles & boulders to 16"

T.T. 76-44

		MC	LL	PI	-4	-200
2.5'	CL	–	30	14	94	58
6.5'	SM	–	•	NP	81	17
10.0'	SW SM	–	•	NP	70	5
15.0'	SC	–	34	20	73	16

SANDY CLAY, light brown to tan, some caliche 1.5'-2.5', some gravel to 1 1/2"

SILTY SANDY GRAVEL, white cemented caliche gravel pockets, 5% cobbles to 7"

GRAVELLY SAND-SILTY GRAVELLY SAND, grey layers of sand & gravel, hard, 10% cobbles to 9"

CLAYEY GRAVELLY SAND, red-brown, highly cemented and hard, 20% cobbles & boulders to 14"

T.T. 76-45

GRAVELLY CLAYEY SAND, tan, slight cementation, several gravels to 3"

SANDY SILT, tan, dense, very fine, some small gravel

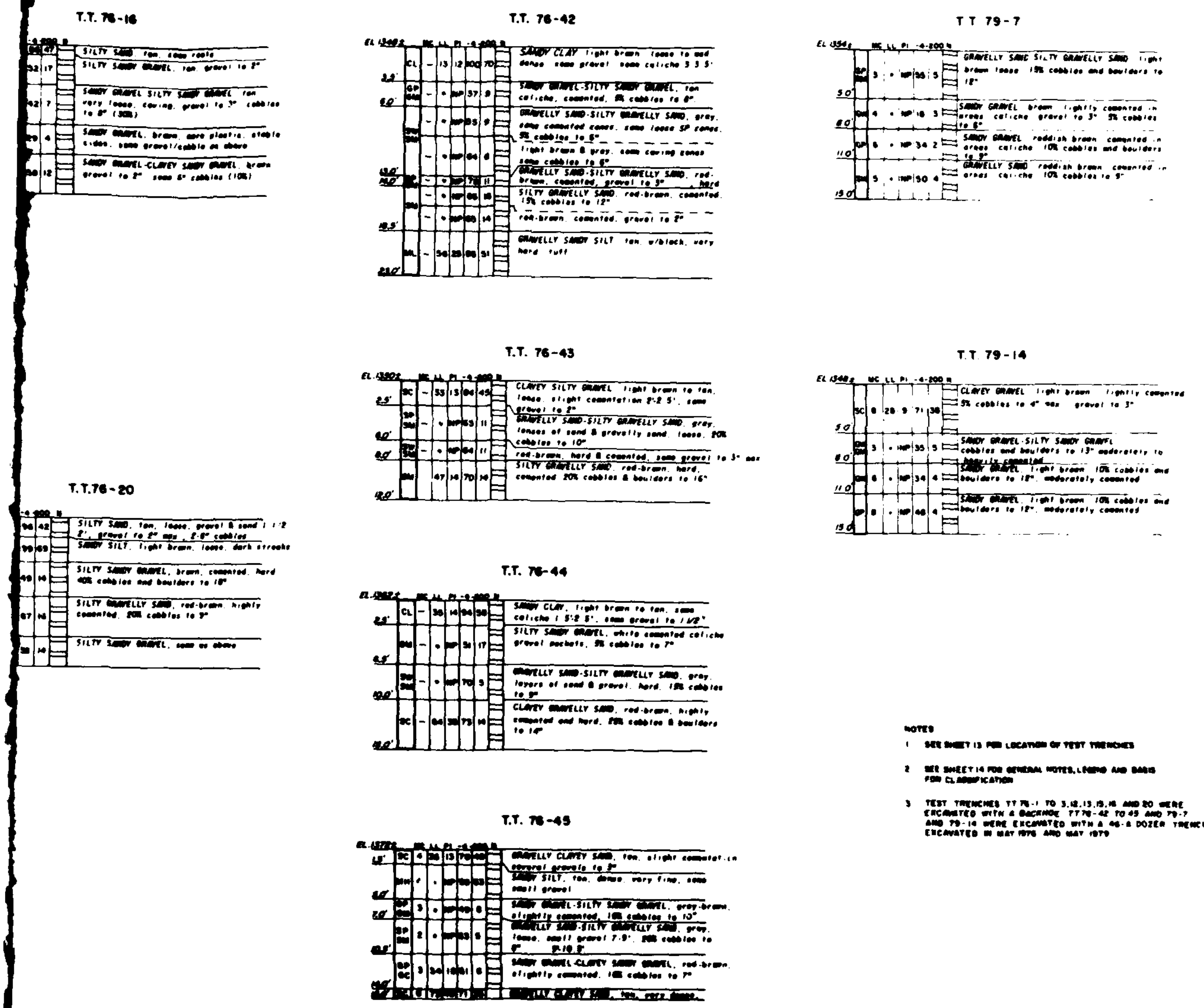
SANDY GRAVEL-SILTY SANDY GRAVEL, grey-brown, slightly cemented, 10% cobbles to 13"

GRAVELLY SAND-SILTY GRAVELLY SAND, grey, loose, small gravel 7-9', 20% cobbles to 8"

SANDY GRAVEL-CLAYEY SANDY GRAVEL, red-brown, slightly cemented, 10% cobbles to 7"

GRAVELLY CLAYEY SAND, tan, very dense.

VALUE ENGINEERING PAYS



NOTES

1 SEE SHEET 13 FOR LOCATION OF TEST TRENCHES

2 SEE SHEET 14 FOR GENERAL NOTES, LEGEND AND BASIS FOR CLASSIFICATION

3 TEST TRENCHES TT 76-1 TO 3, 12, 13, 15, 16 AND 20 WERE EXCAVATED WITH A BACKHOE. TT 76-42 TO 45 AND 79-7 AND 79-14 WERE EXCAVATED WITH A D6-A DOZER. TRENCHES EXCAVATED IN MAY 1976 AND MAY 1979

VERT. SCALE FEET

REVISIONS

U.S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

LCS

D.R.V.

TY

GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA

ADOBE DAM

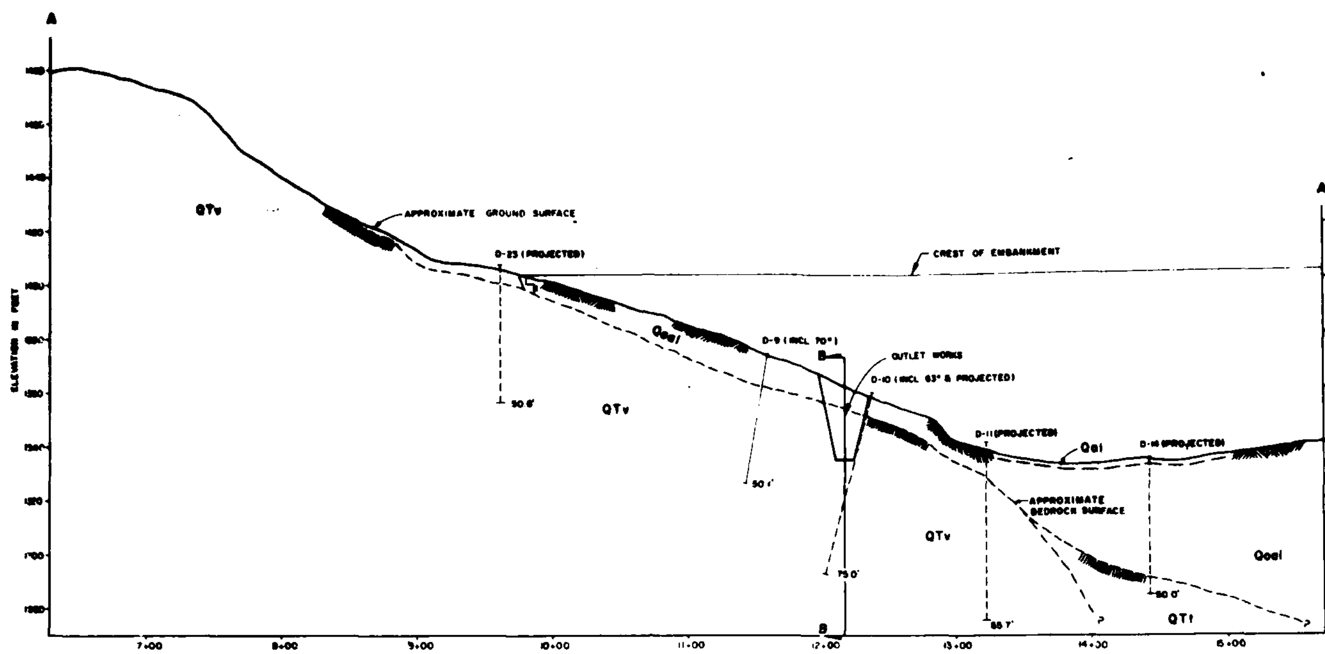
EMBANKMENT FOUNDATION

SOIL LOGS

SAFETY PAYS

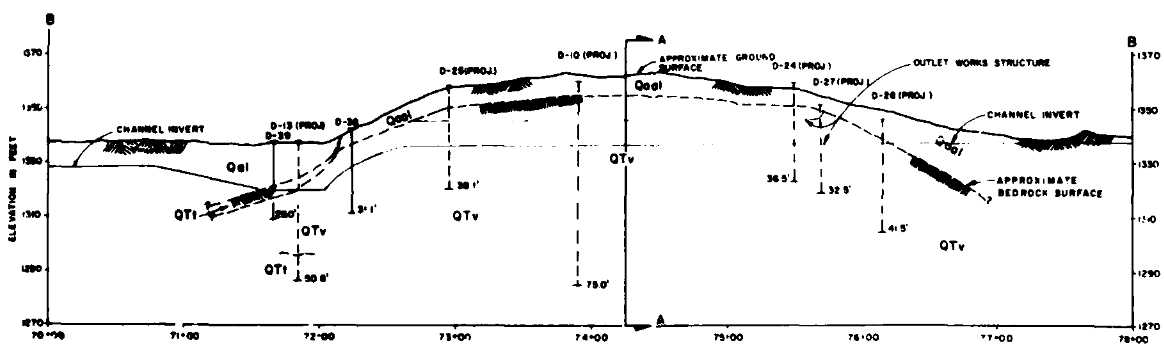
PLATE 8

2



PROFILE A-A (WEST ABUTMENT)

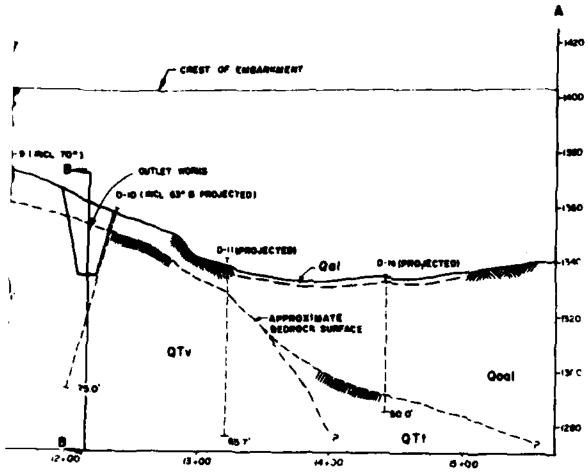
HORIZ SCALE 1 IN = 40 FT
VERT SCALE 1 IN = 20 FT



PROFILE B-B ALONG ℄ OUTLET WORKS

HORIZ SCALE 1 IN = 40 FT
VERT SCALE 1 IN = 20 FT

SCALE
HORIZ SCALE
VERT SCALE



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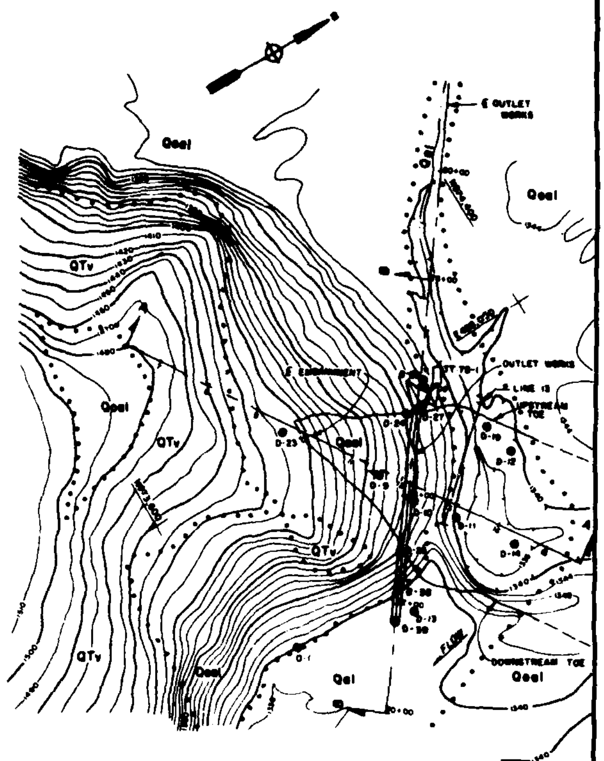


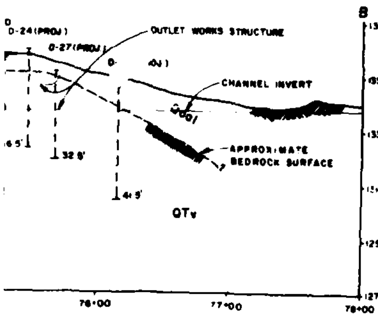
PLAN (WEST ABUTMENT AND OUTLET WORKS)

SCALE 1 IN = 100 FT

CONTOURS ARE IN 4 FT AND 10 FT INTERVALS

GENERAL NOTES

1. SEE SHEET 3 FOR GENERAL GEOLOGY OF AREA AND LEGEND
2. SEE SHEETS 4&6 FOR LOCATION OF OTHER SEISMIC REFRACTIVE SURVEY LINES
3. SEE SHEET 10, 11 AND 12 FOR LOGS OF DIAMOND CORE HOLES AND TEST TRENCH



DATUM IS MEAN SEA LEVEL

SCALE 1 IN = 100 FT

SCALE 1 IN = 40 FT

SCALE 1 IN = 20 FT

REVISIONS

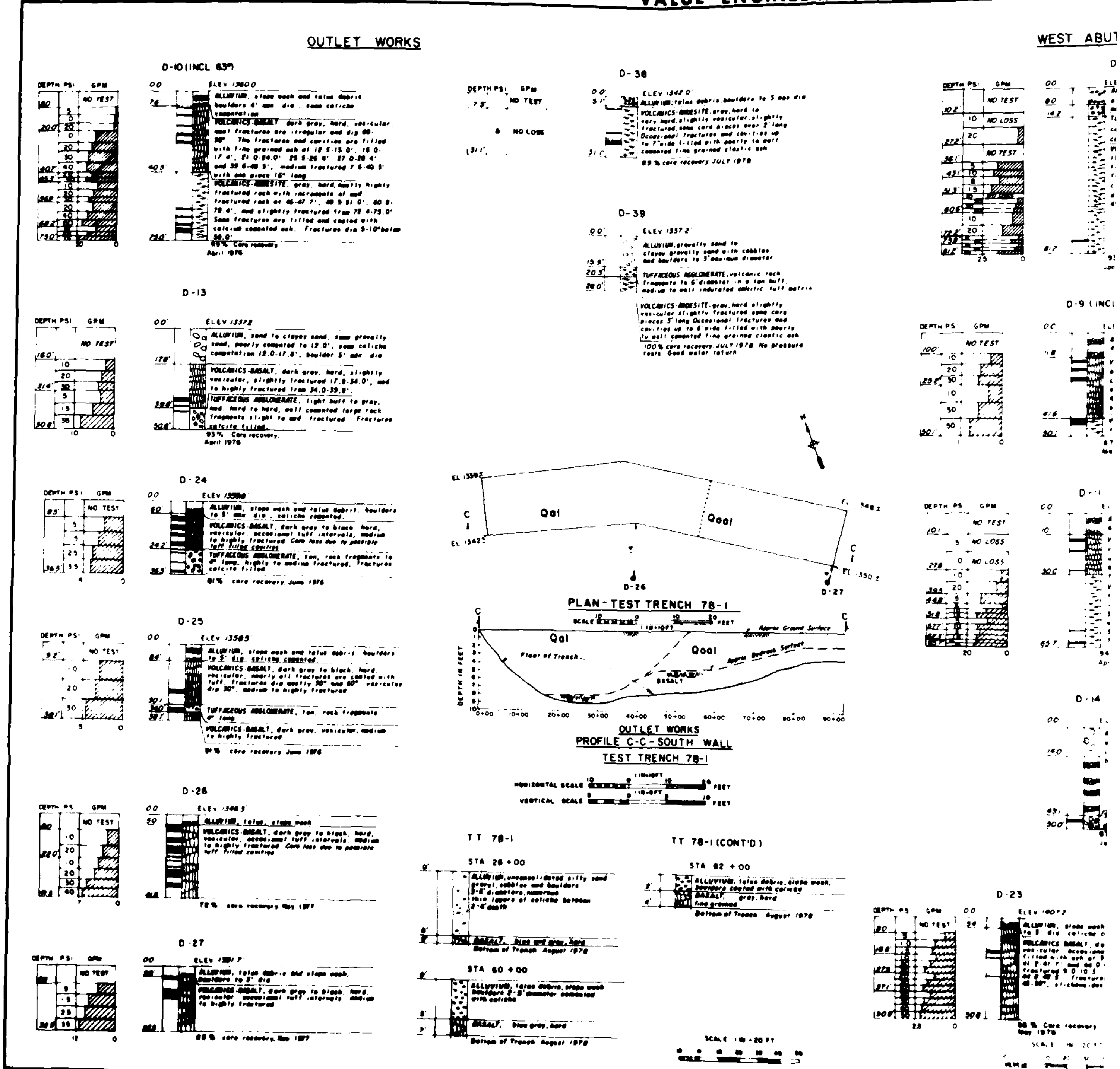
U.S. ARMY ENGINEER DISTRICT LOS ANGELES CORPS OF ENGINEERS

GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA

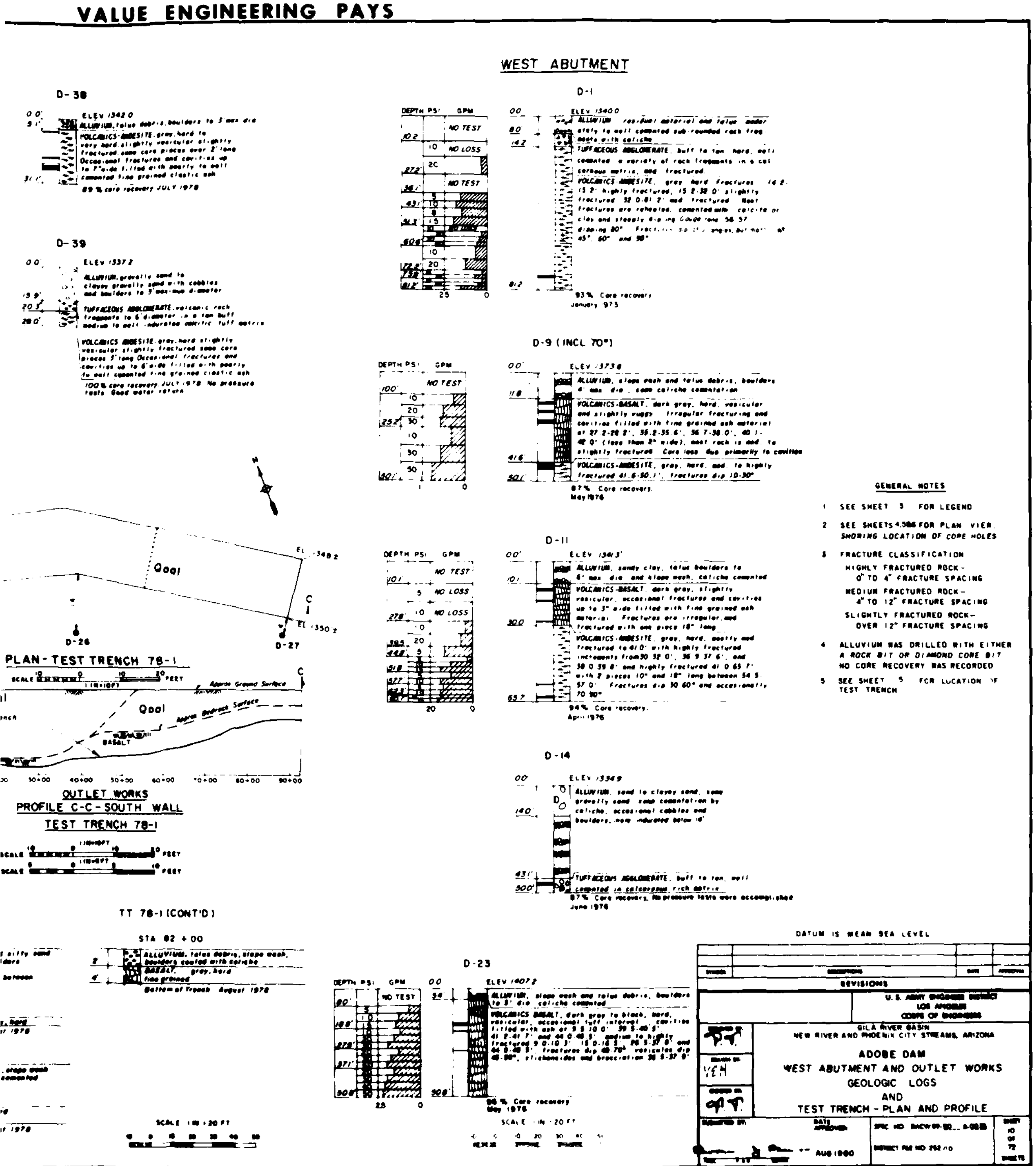
ADOBE DAM
WEST ABUTMENT AND OUTLET WORKS
GEOLOGY AND FOUNDATION EXPLORATION
PLAN AND PROFILES

PLATE 9

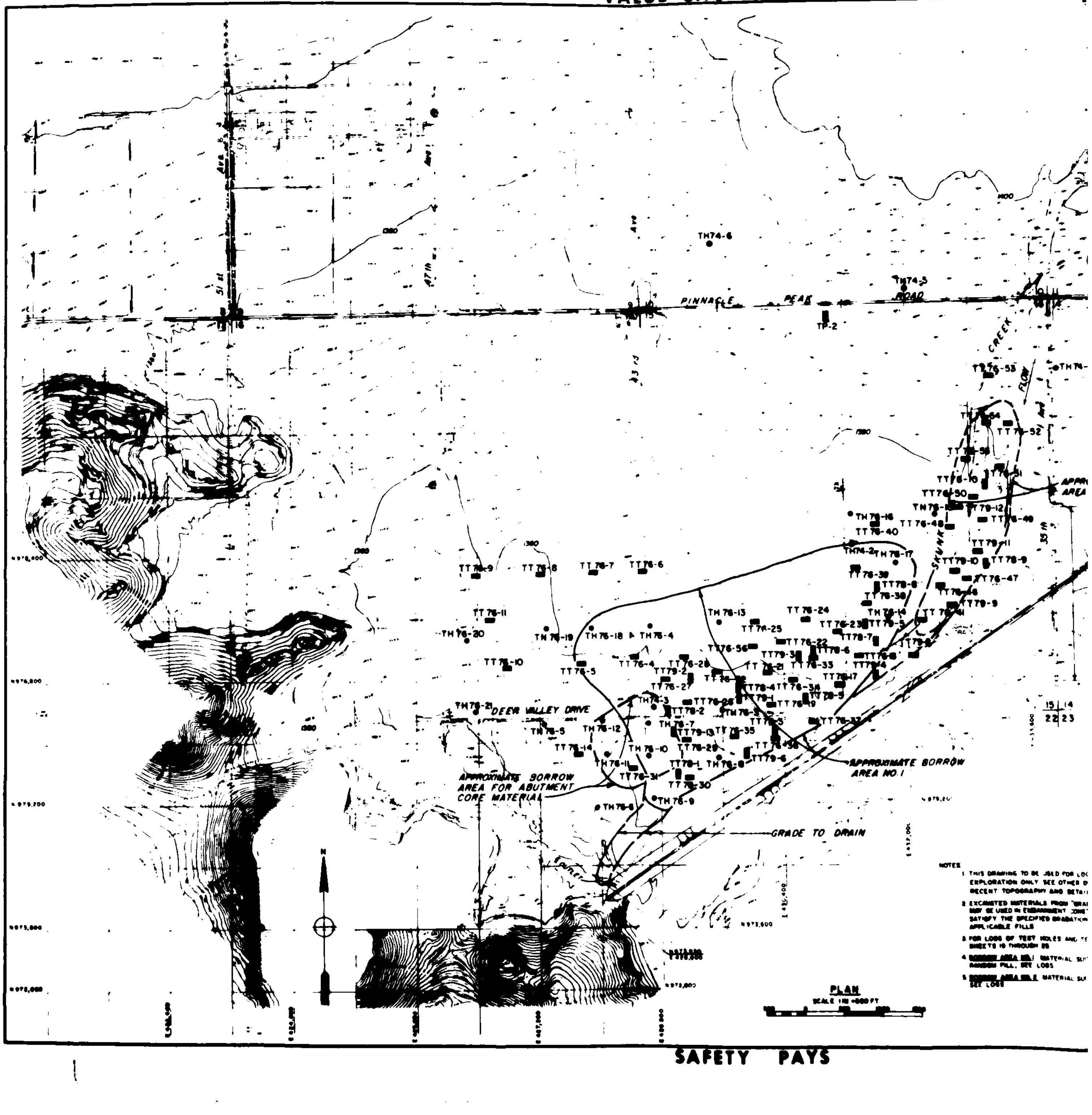
VALUE ENGINEERING PAYS



SAFETY PAYS


WEST ABUTMENT
D-1
D-9 (INCL 70°)
D-11
D-14
D-23
D-38
D-39
DEPTH PSI GPM
NO TEST
NO LOSS
PLAN-TEST TRENCH 78-1
Qoal
D-26
D-27
OUTLET WORKS
PROFILE C-C-SOUTH WALL
TEST TRENCH 78-1
TT 78-1 (CONT'D)
STA 82 + 00
GENERAL NOTES
1 SEE SHEET 3 FOR LEGEND
2 SEE SHEETS 4,5&6 FOR PLAN VIEW SHOWING LOCATION OF CORE HOLES
3 FRACTURE CLASSIFICATION
HIGHLY FRACTURED ROCK - 0" TO 4" FRACTURE SPACING
MEDIUM FRACTURED ROCK - 4" TO 12" FRACTURE SPACING
SLIGHTLY FRACTURED ROCK - OVER 12" FRACTURE SPACING
4 ALLUVIUM WAS DRILLED WITH EITHER A ROCK BIT OR DIAMOND CORE BIT NO CORE RECOVERY WAS RECORDED
5 SEE SHEET 5 FOR LOCATION OF TEST TRENCH
DATUM IS MEAN SEA LEVEL
REVISIONS
U.S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS
GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA
ADOBE DAM
WEST ABUTMENT AND OUTLET WORKS
GEOLOGIC LOGS
AND
TEST TRENCH - PLAN AND PROFILE
AUG 1980

VALUE ENGINEERING PAYS



SAFETY PAYS

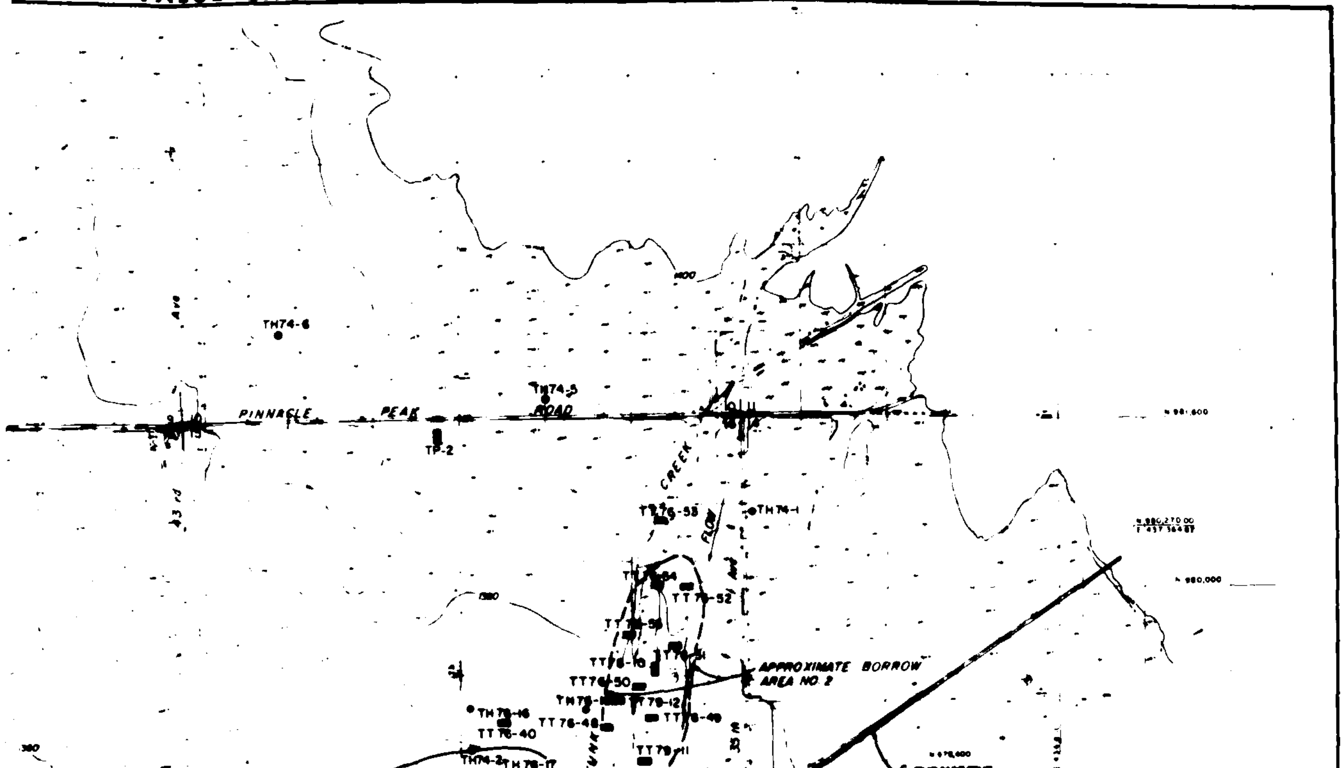
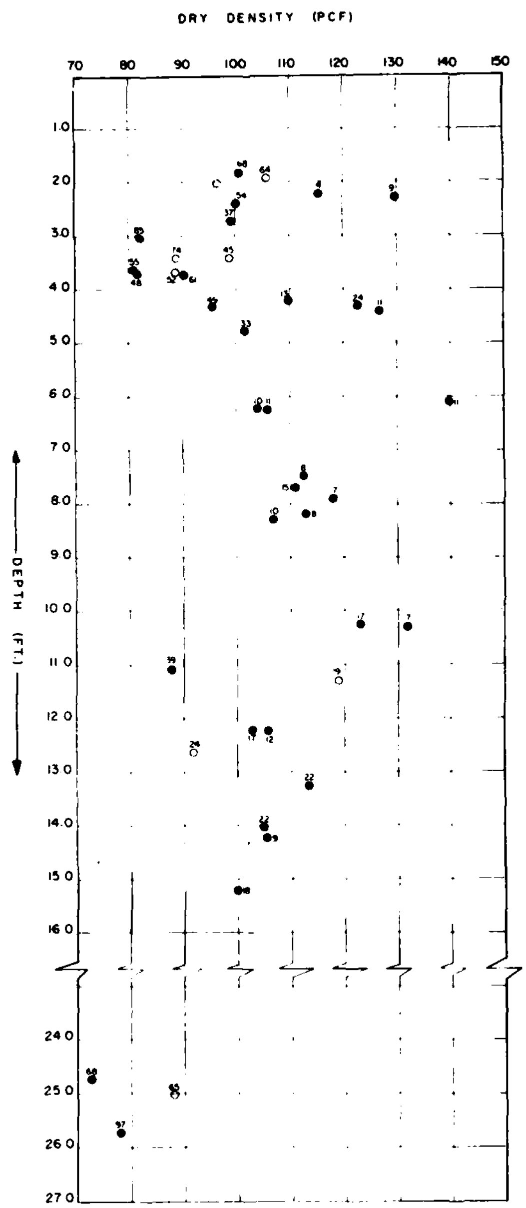
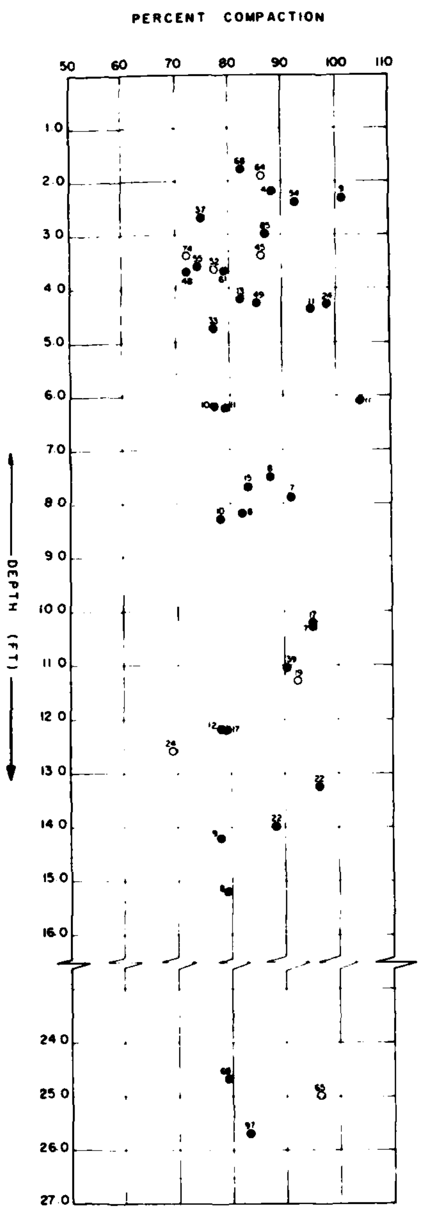
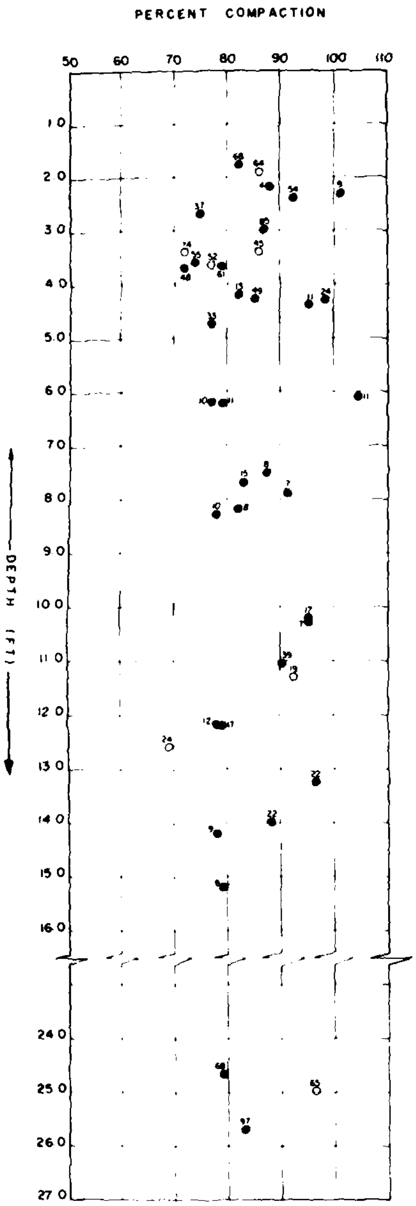

PINNACLE PEAK ROAD
SKUNK CREEK
APPROXIMATE BORROW AREA NO. 2
APPROXIMATE BORROW AREA NO. 1
GRADE TO DRAIN
TH74-6
TH74-5
TH74-1
TP-2
TH 76-13
TH 76-4
TT 76-24
TT 76-25
TT 76-5
TT 76-6
TT 76-7
TH 76-9
TH 76-10
TH 76-12
TH 76-16
TH 76-17
TT 76-40
TT 76-47
TT 76-48
TT 76-49
TT 76-50
TT 76-52
TT 76-53
TT 76-56
TT 79-9
TT 79-10
TT 79-11
TT 79-12
LEGEND
TH 76-4 LOCATION AND NUMBER OF TEST HOLE, INCLUDING YEAR DRILLED
TT 76-2 LOCATION AND NUMBER OF TEST TRENCH, INCLUDING YEAR EXCAVATED
NOTES
1 THIS DRAWING TO BE USED FOR LOCATION OF EXPLORATION ONLY. SEE OTHER DRAWINGS FOR RECENT TOPOGRAPHY AND DETAILS OF CONSTRUCTION
2 EXCAVATED MATERIALS FROM "GRADE TO DRAIN" OPERATIONS MAY BE USED IN EMBANKMENT CONSTRUCTION WHERE THEY SATISFY THE SPECIFIED GRADATION REQUIREMENTS FOR THE APPLICABLE FILLS
3 FOR LOGS OF TEST HOLES AND TEST TRENCHES, SEE SHEETS 19 THROUGH 26
4 BORROW AREA NO. 1: MATERIAL SUITABLE FOR CORE AND RANDOM FILL, SEE LOGS
5 BORROW AREA NO. 2: MATERIAL SUITABLE FOR RANDOM FILL SEE LOGS.
PLAN
DATUM IS MEAN SEA LEVEL
GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA
ADOBE DAM
BORROW EXPLORATION
PLAN

PLATE II

2


DRY DENSITY (PCF)
70 80 90 100 110 120 130 140 150
DEPTH (FT.)
1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0 11.0 12.0 13.0 14.0 15.0 16.0 24.0 25.0 26.0 27.0


PERCENT COMPACTION
50 60 70 80 90 100 110
DEPTH (FT.)
1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0 11.0 12.0 13.0 14.0 15.0 16.0 24.0 25.0 26.0 27.0



LEGEND

●	IN-PLACE DENSITY DETERMINED BY THE SAND CONE METHOD
○	IN-PLACE DENSITY DETERMINED BY THE BULK DENSITY METHOD
●12	NUMERAL INDICATES PERCENT PASSING NO 200 SIEVE
P.C.F.	POUNDS PER CUBIC FOOT

NOTES:
PERCENT COMPACTION DETERMINED USING COMPACTION TEST ASTM D698-70

SYMBOL	DESCRIPTION	DATE	APPROVAL

REVISIONS

U.S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

DESIGNED BY: TY
DRAWN BY: J.W.
CHECKED BY: TY

GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA

ADOBE DAM

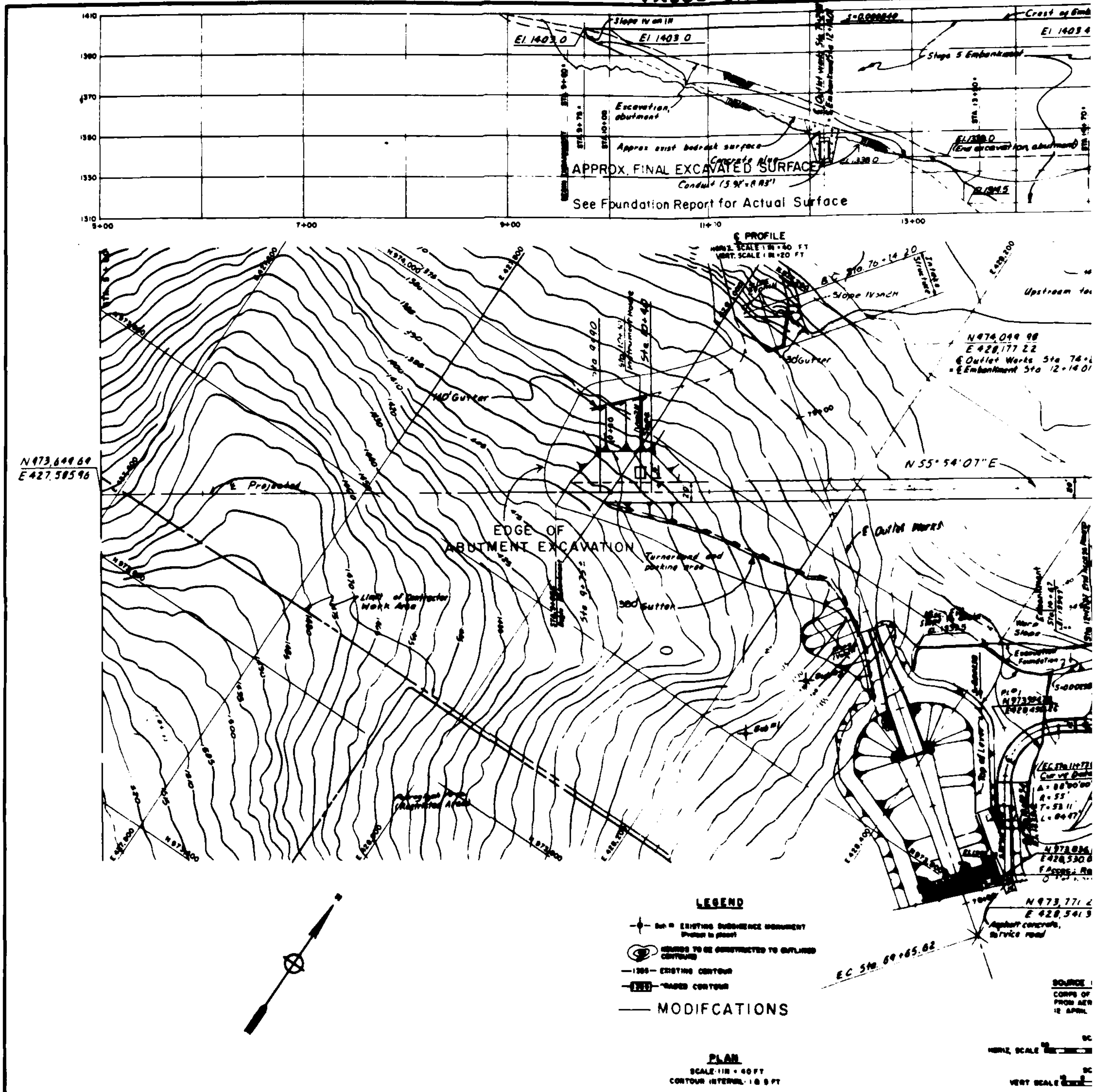
EMBANKMENT FOUNDATION

IN-PLACE DENSITY

SUBMITTED BY:
APPROVED
APPROVAL RECOMMENDED
SPEC NO DACW09
DISTRICT FILE NO
DATE

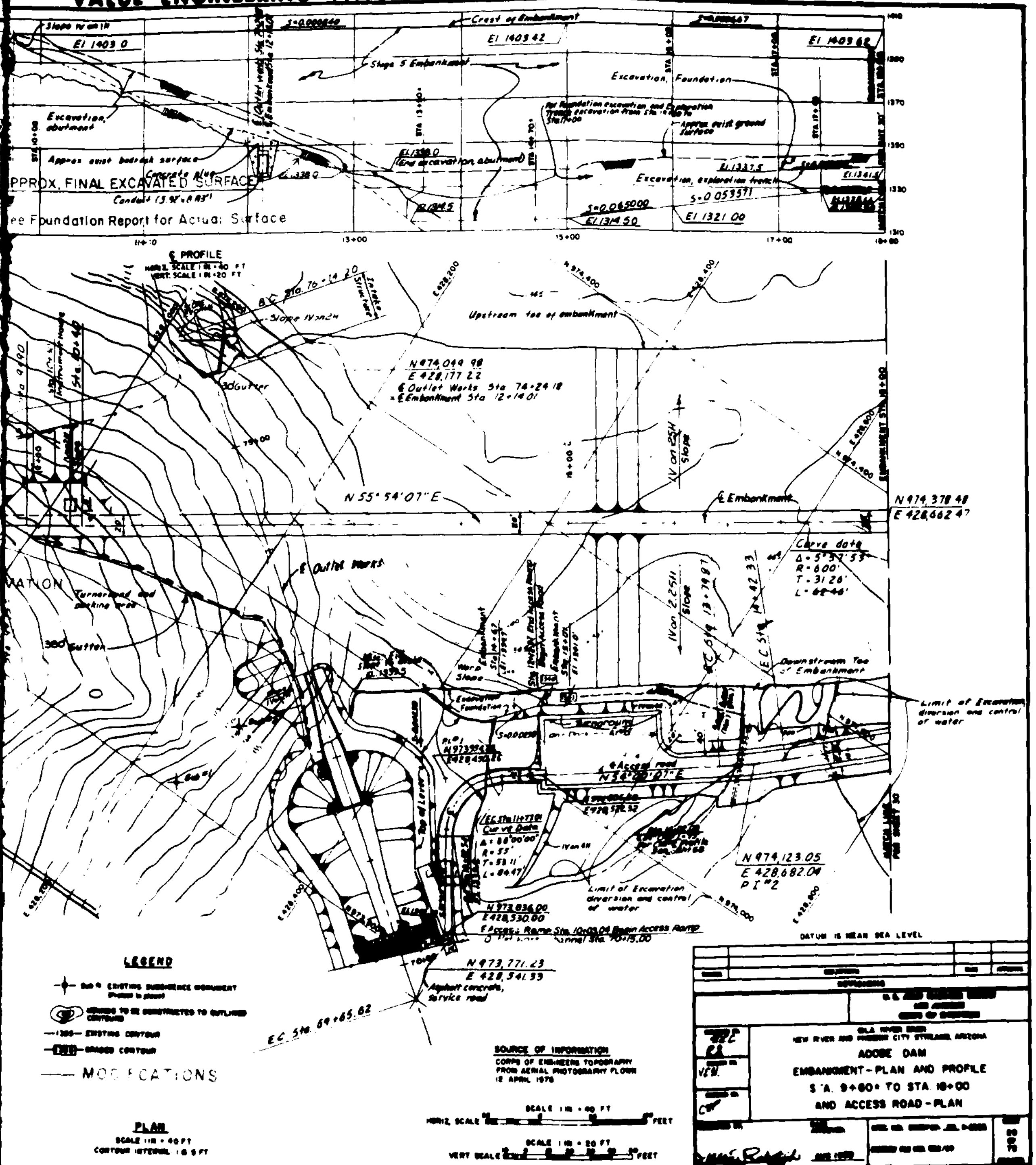
PLATE 18

VALUE ENGINEERING PAYS



SAFETY PAYS

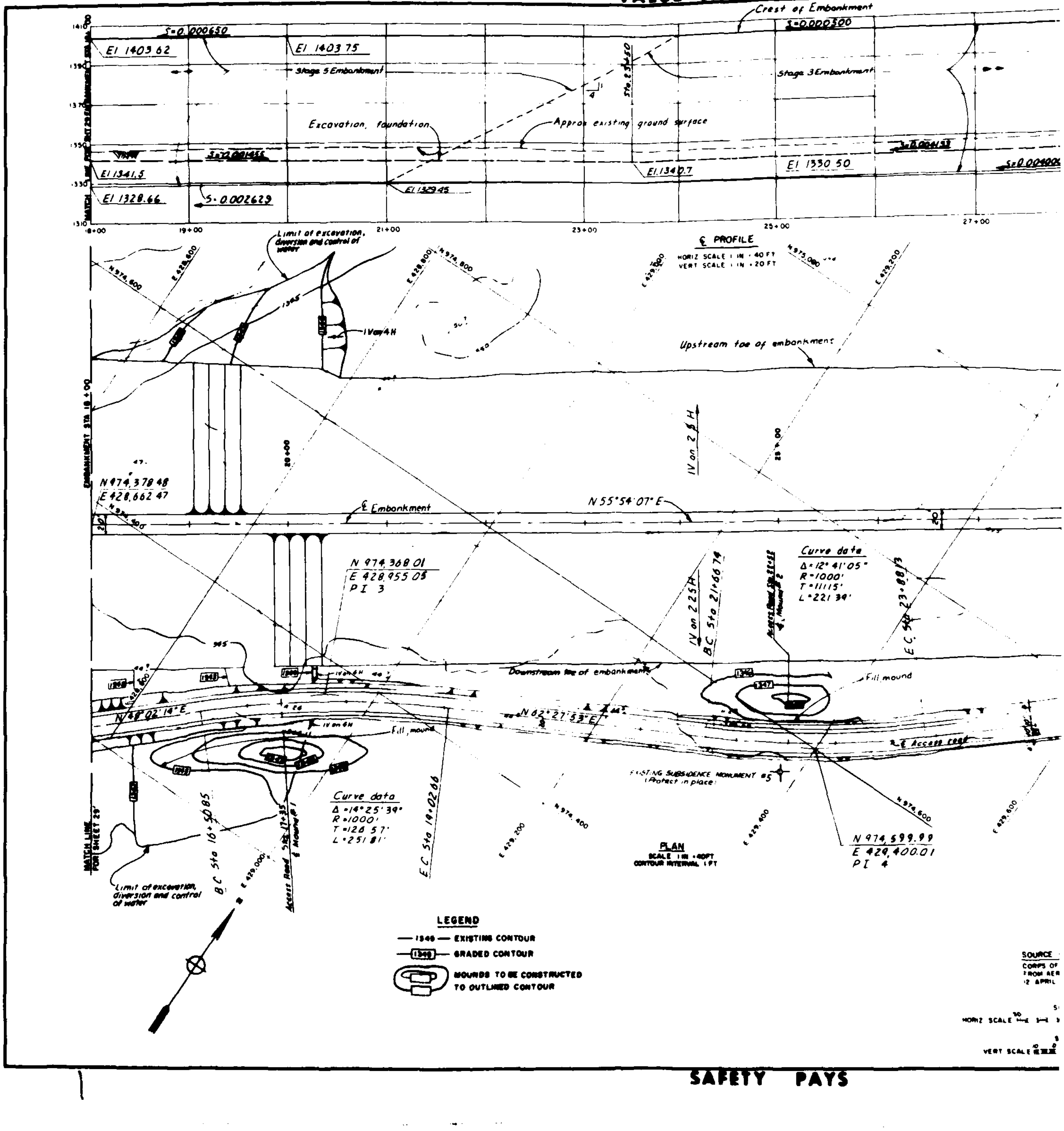
VALUE ENGINEERING PAYS



SAFETY PAYS

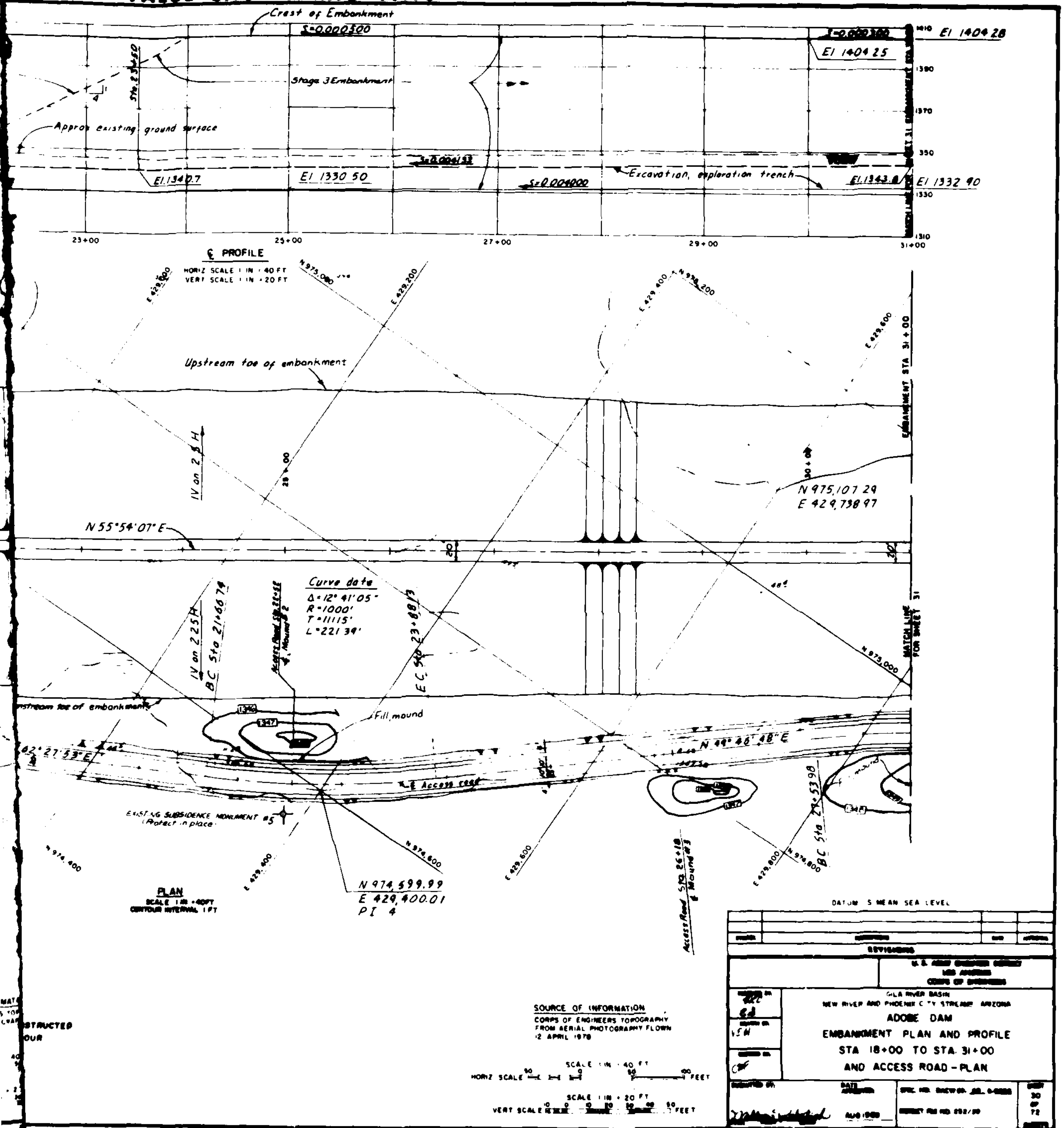
PLATE 13

VALUE ENGINEERING PAYS



SAFETY PAYS

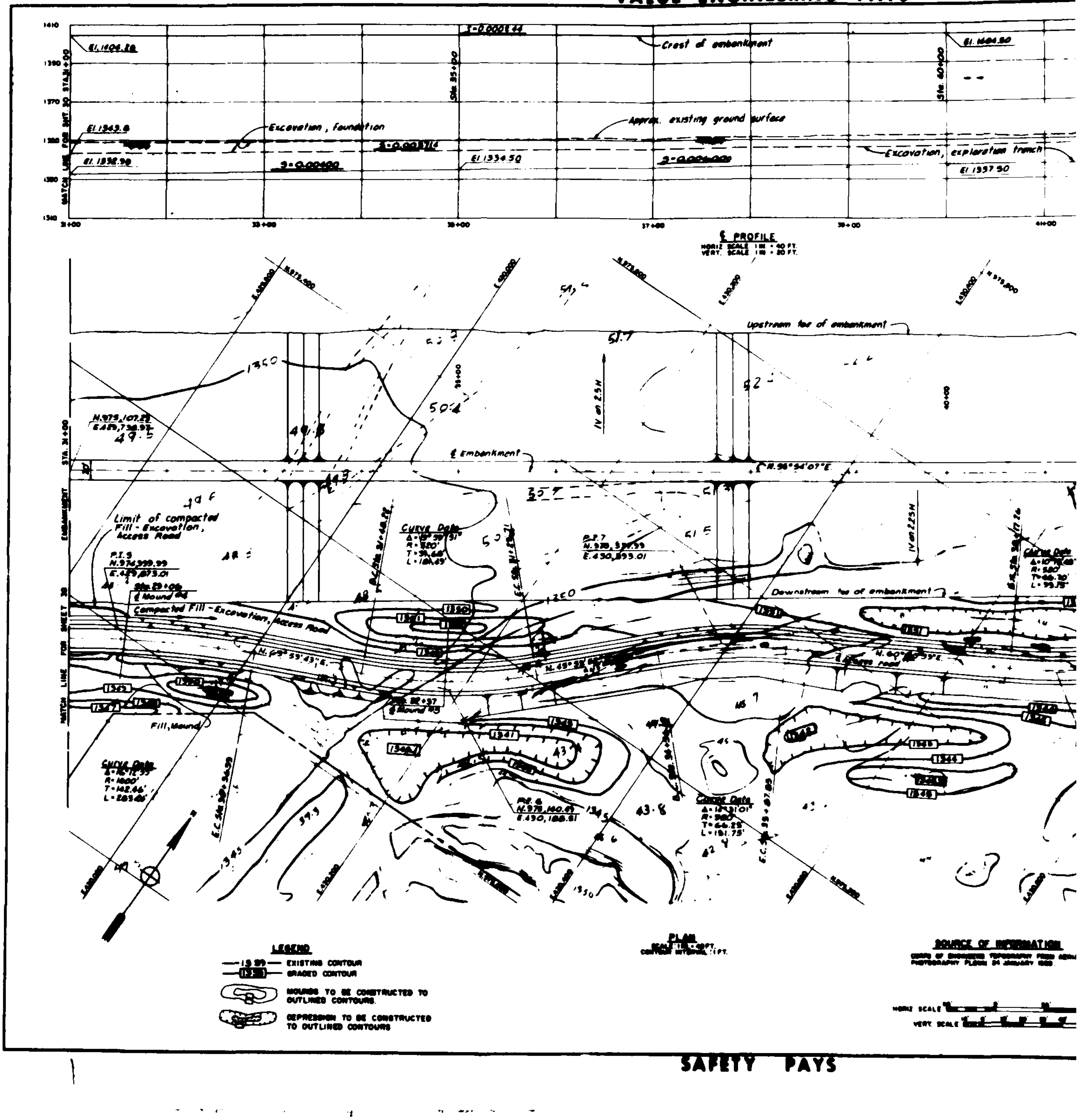
VALUE ENGINEERING PAYS



SAFETY PAYS

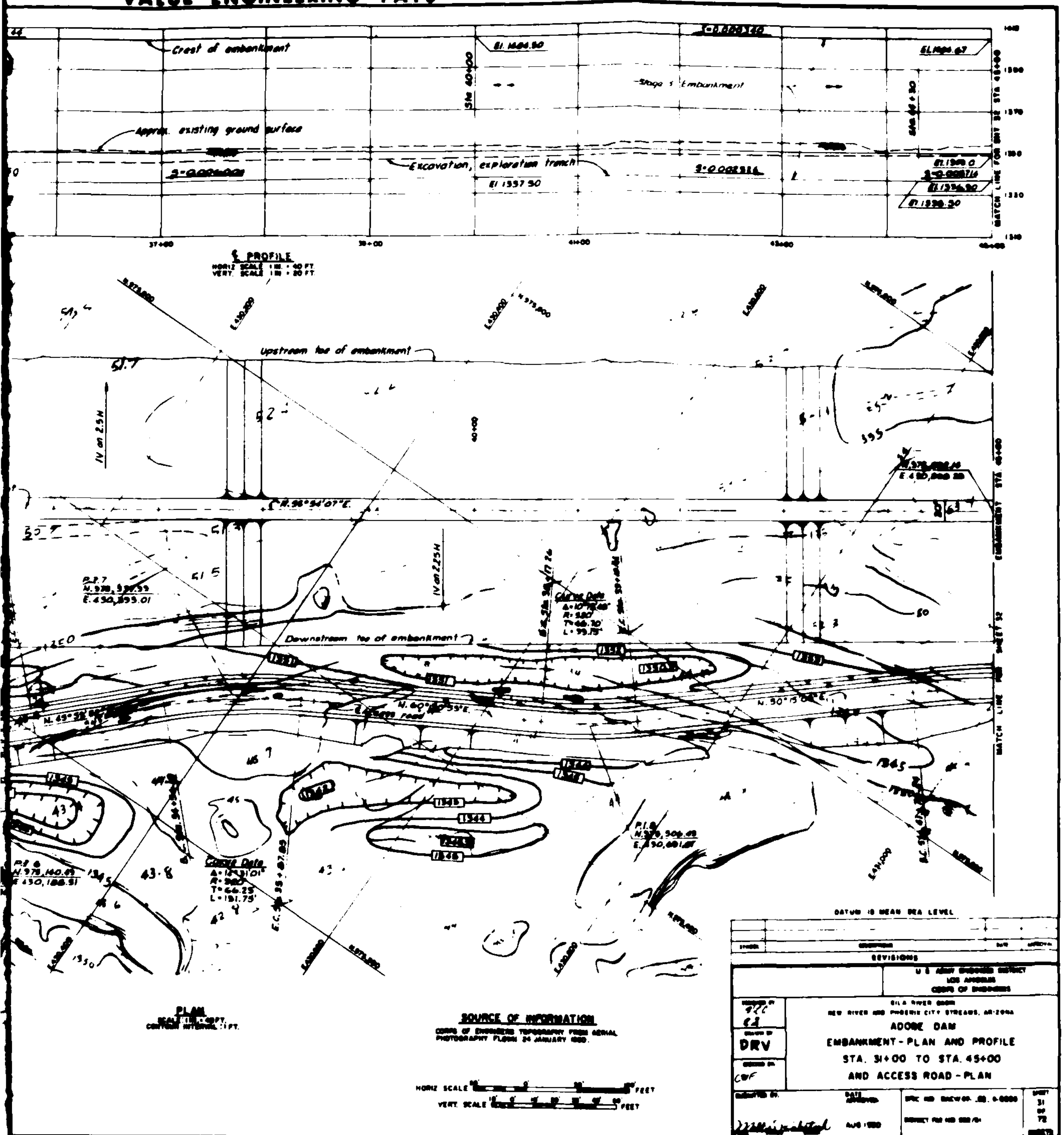
PLATE 14

VALUE ENGINEERING PAYS



SAFETY PAYS

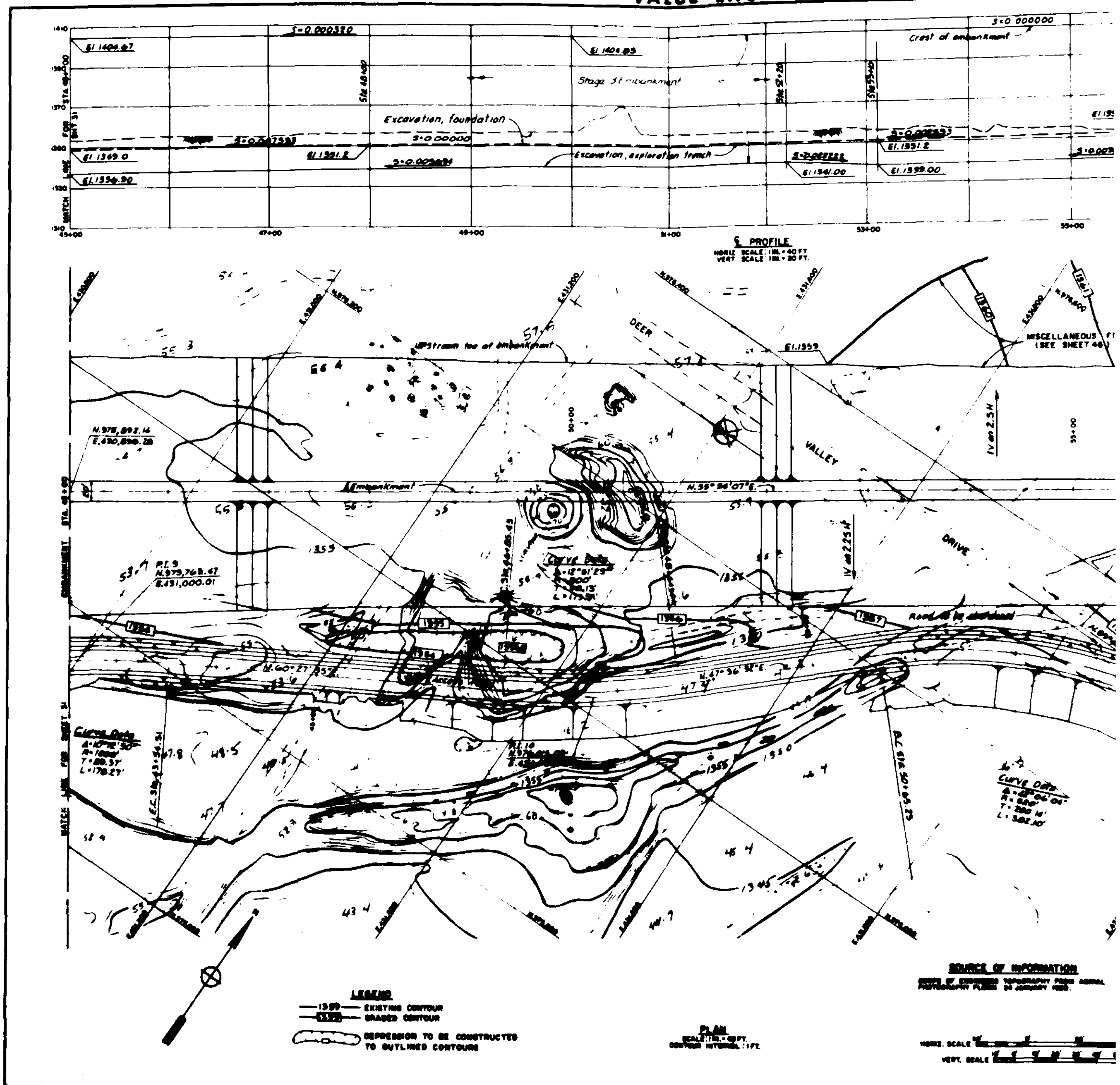
VALUE ENGINEERING PAYS



SAFETY PAYS

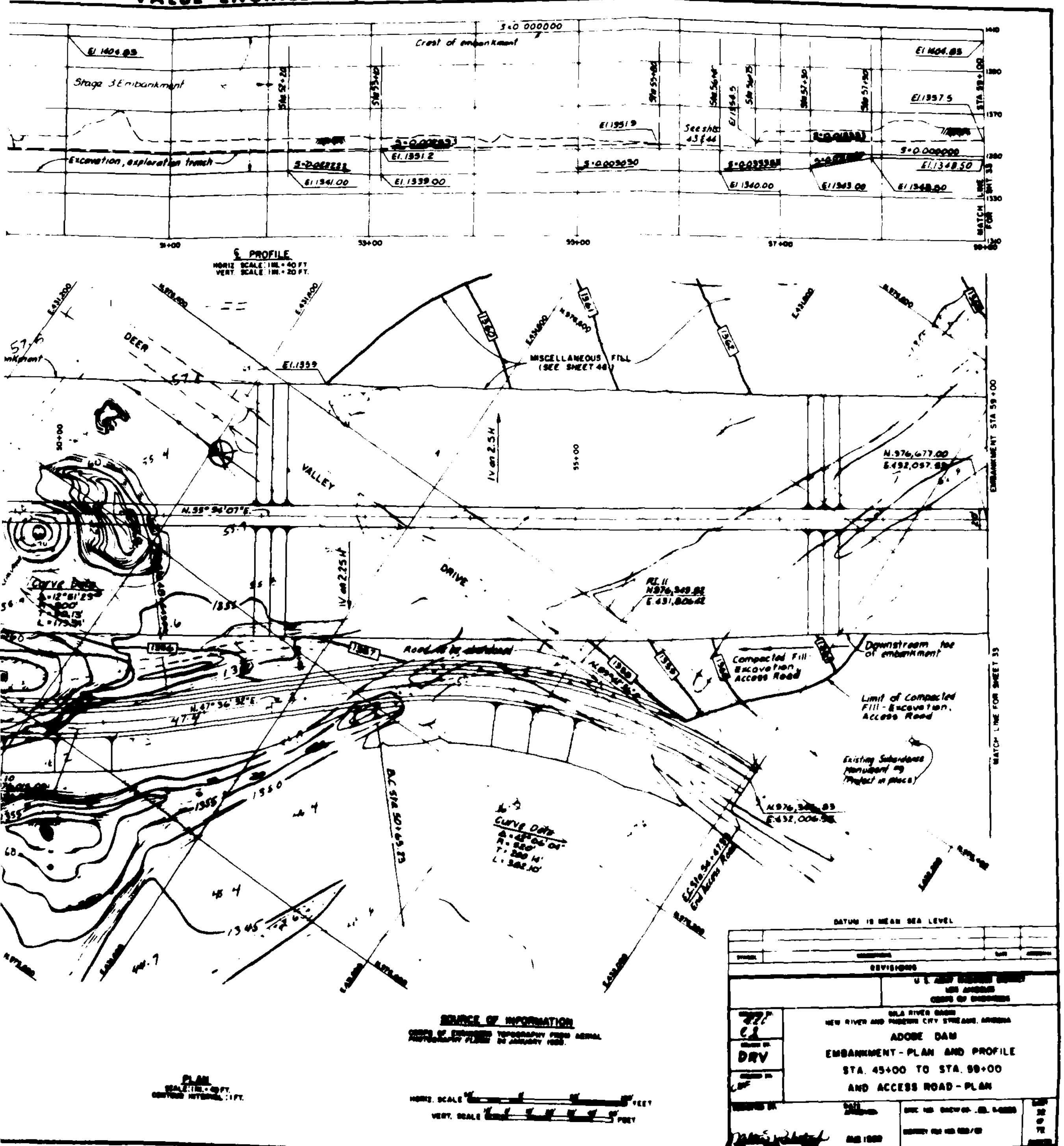
PLATE 15

VALUE ENGINEERING PAYS



SAFETY PAYS

VALUE ENGINEERING PAYS

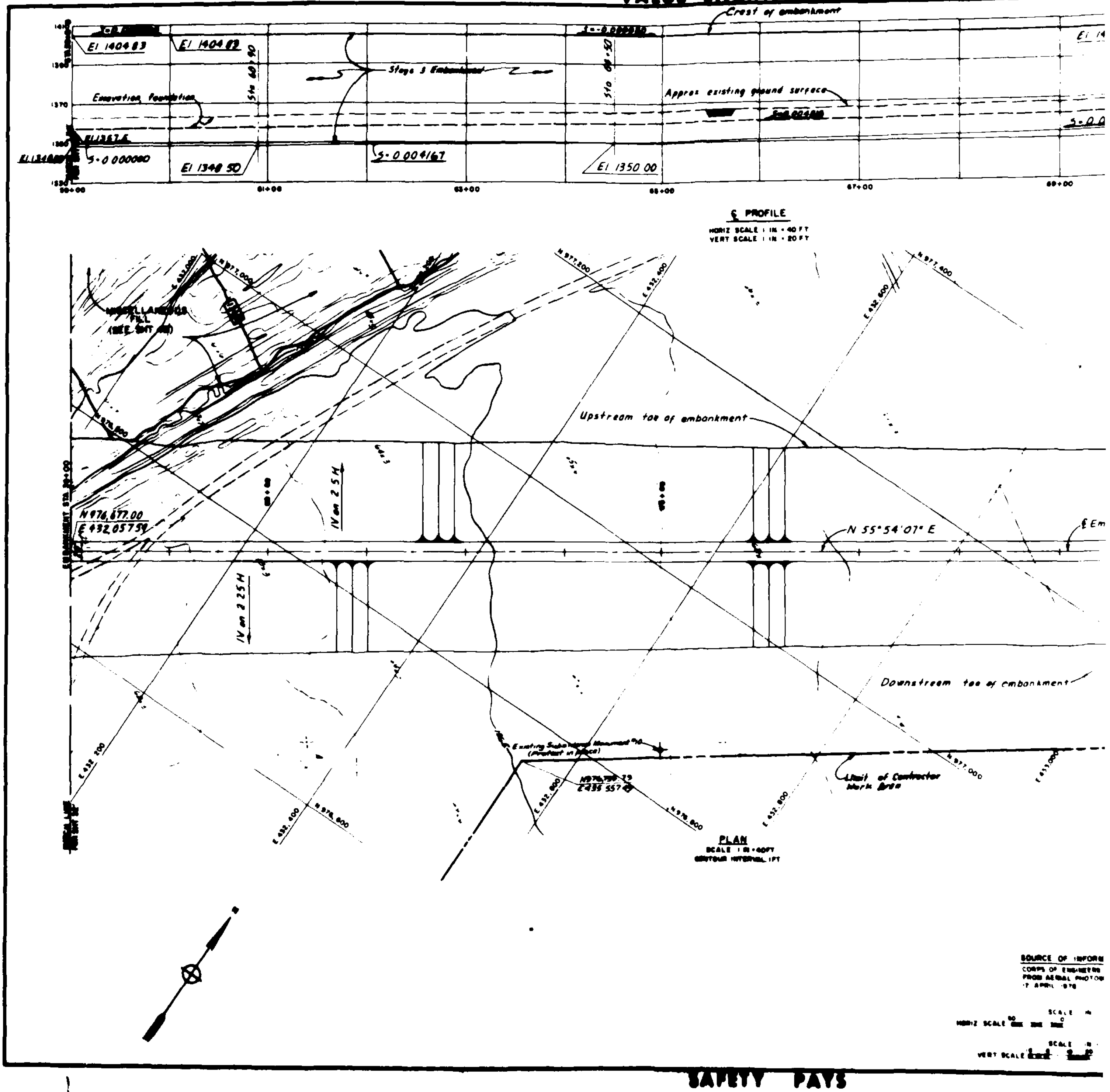


SAFETY PAYS

PLATE 16

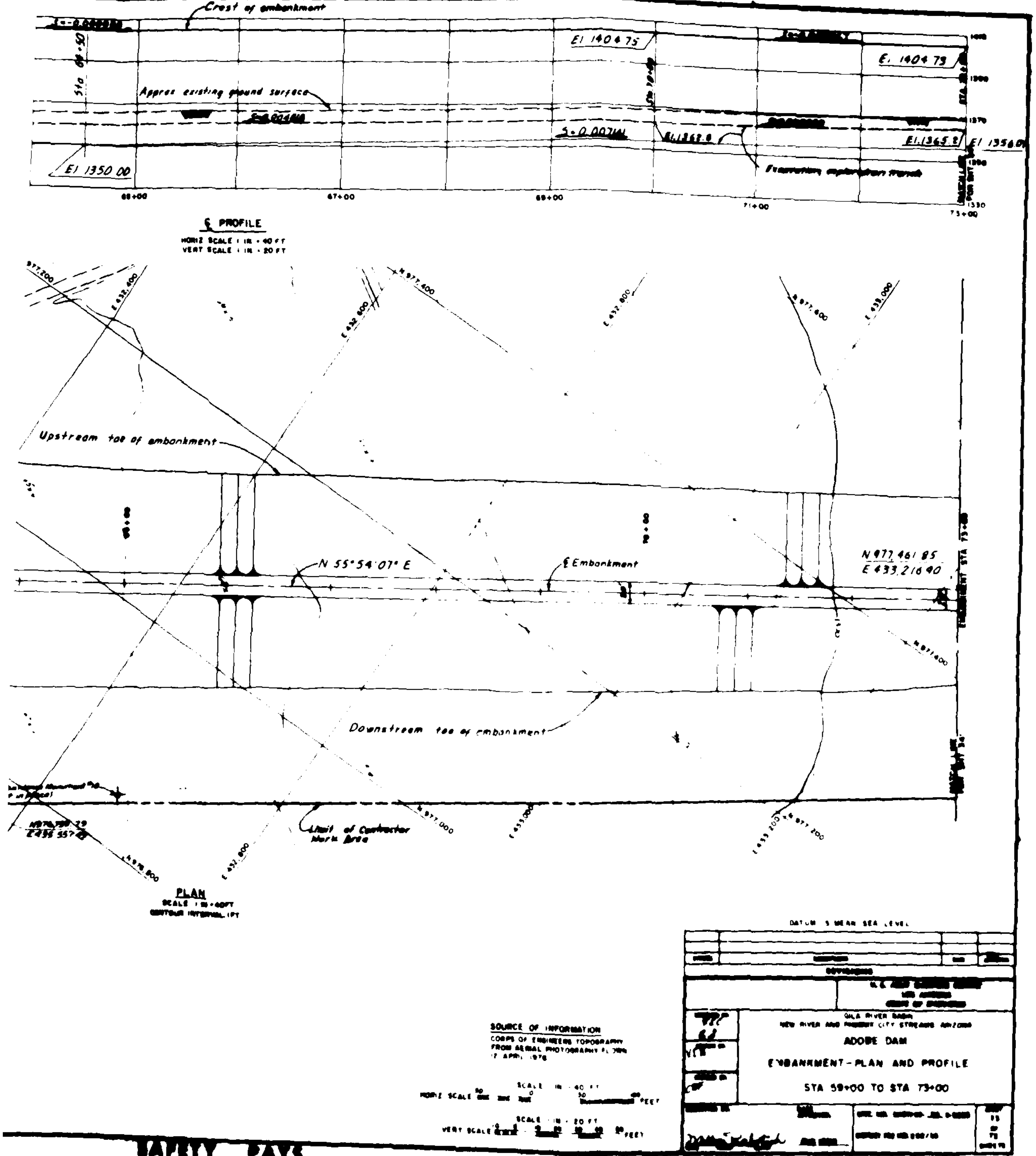
2

VALUE ENGINEERING PAYS



SAFETY PAYS

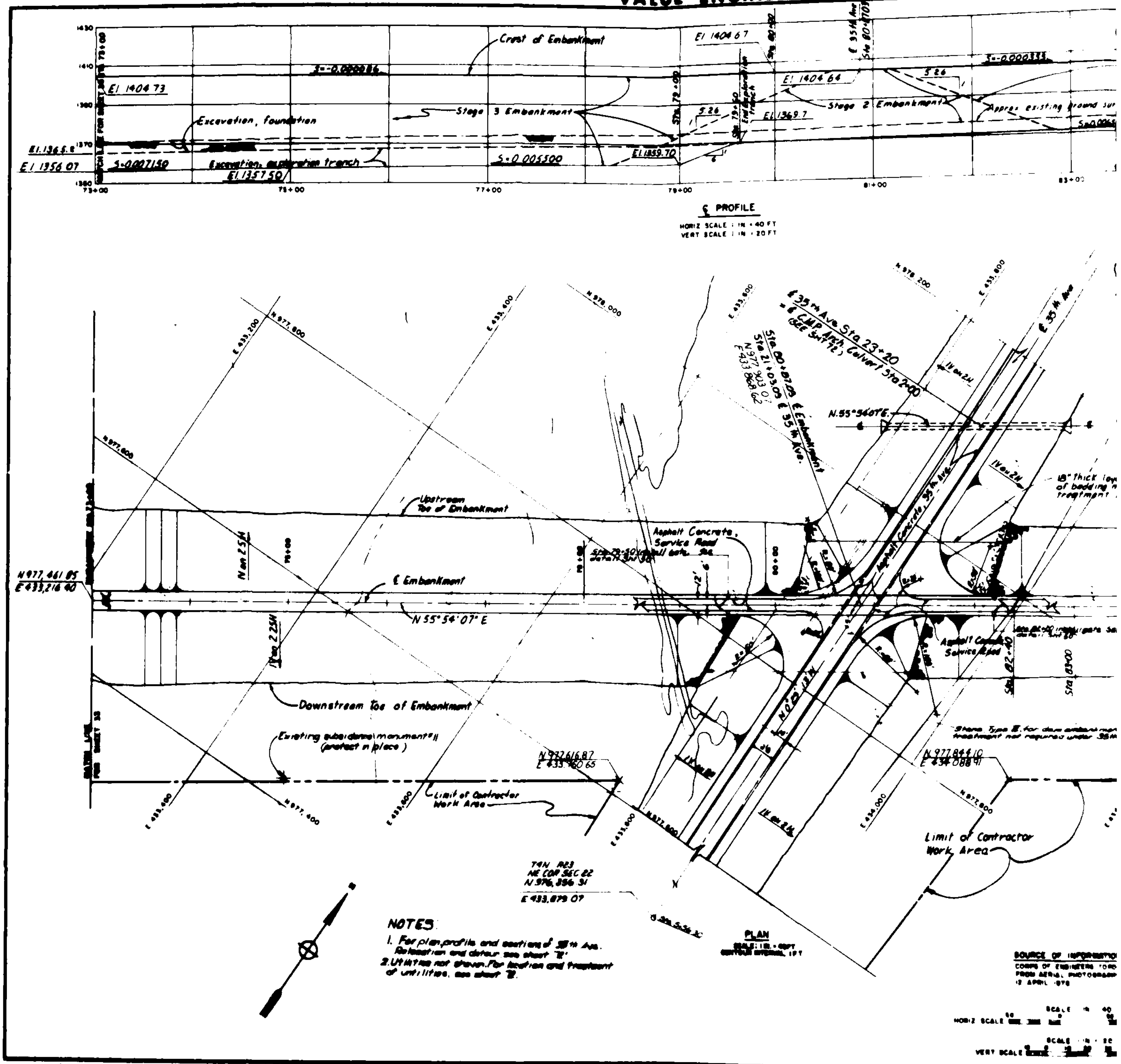
VALUE ENGINEERING PAYS



SAFETY PAYS

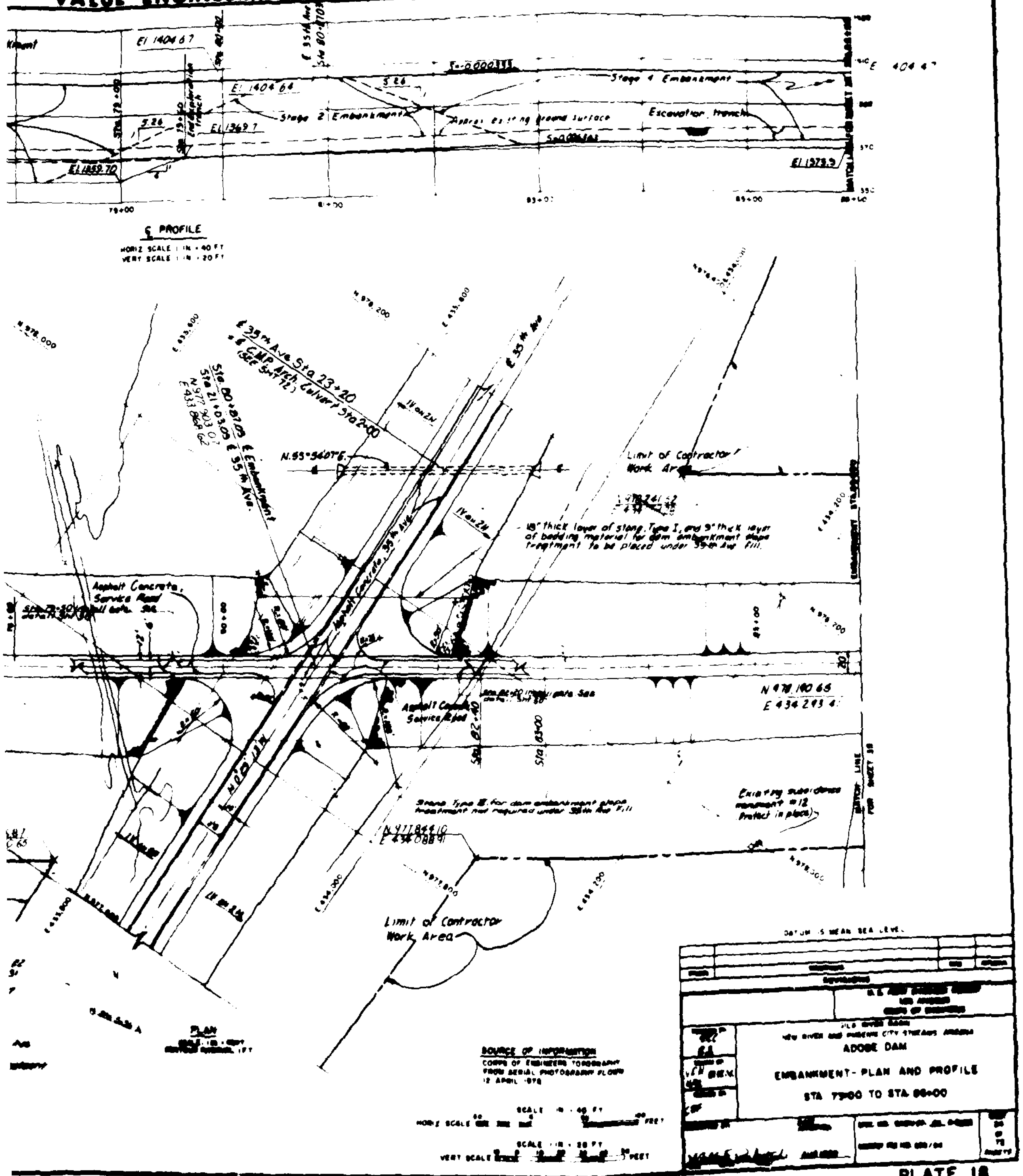
PLATE 17

VALUE ENGINEERING PAYS



SAFETY PAYS

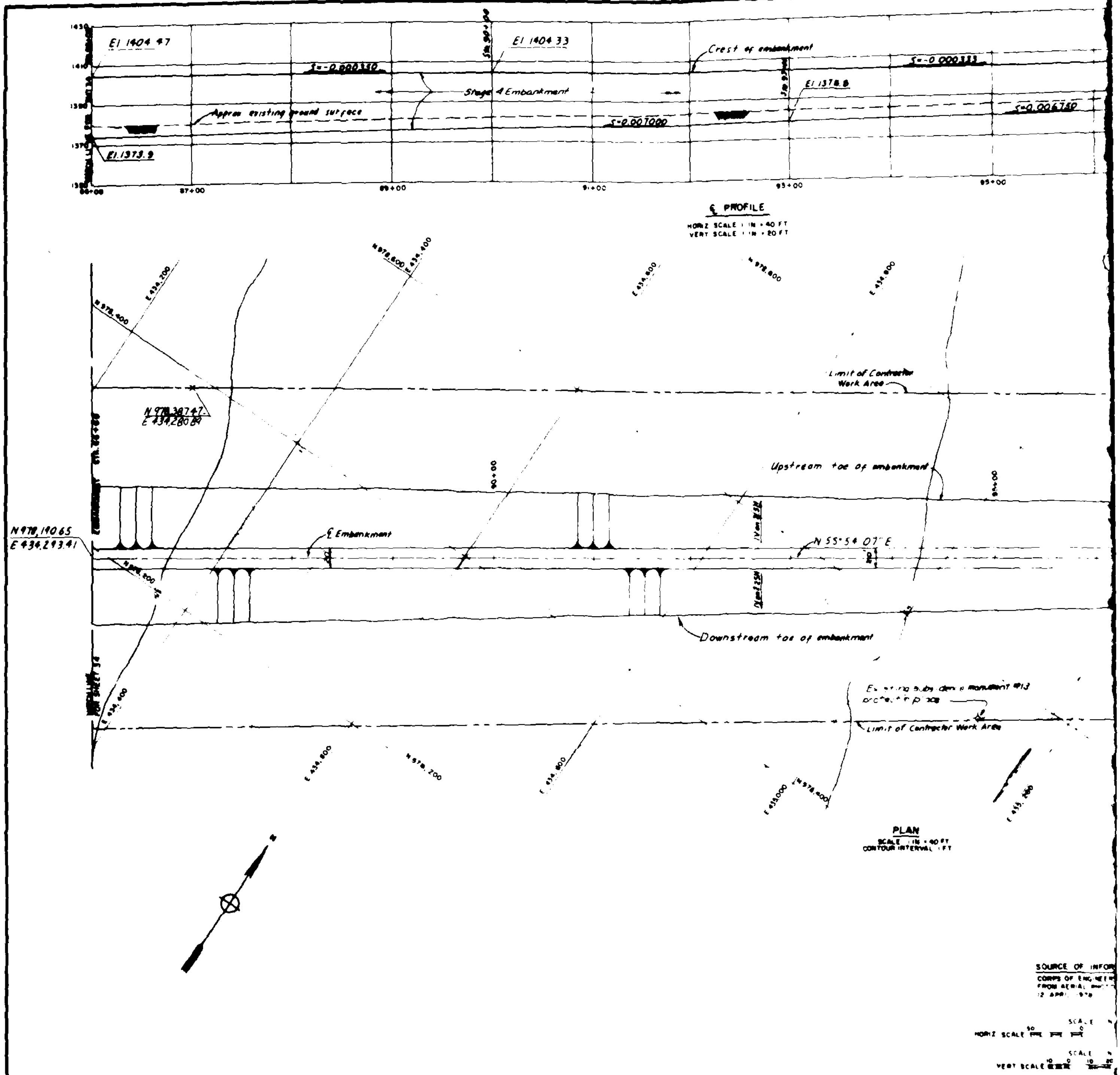
VALUE ENGINEERING PAYS



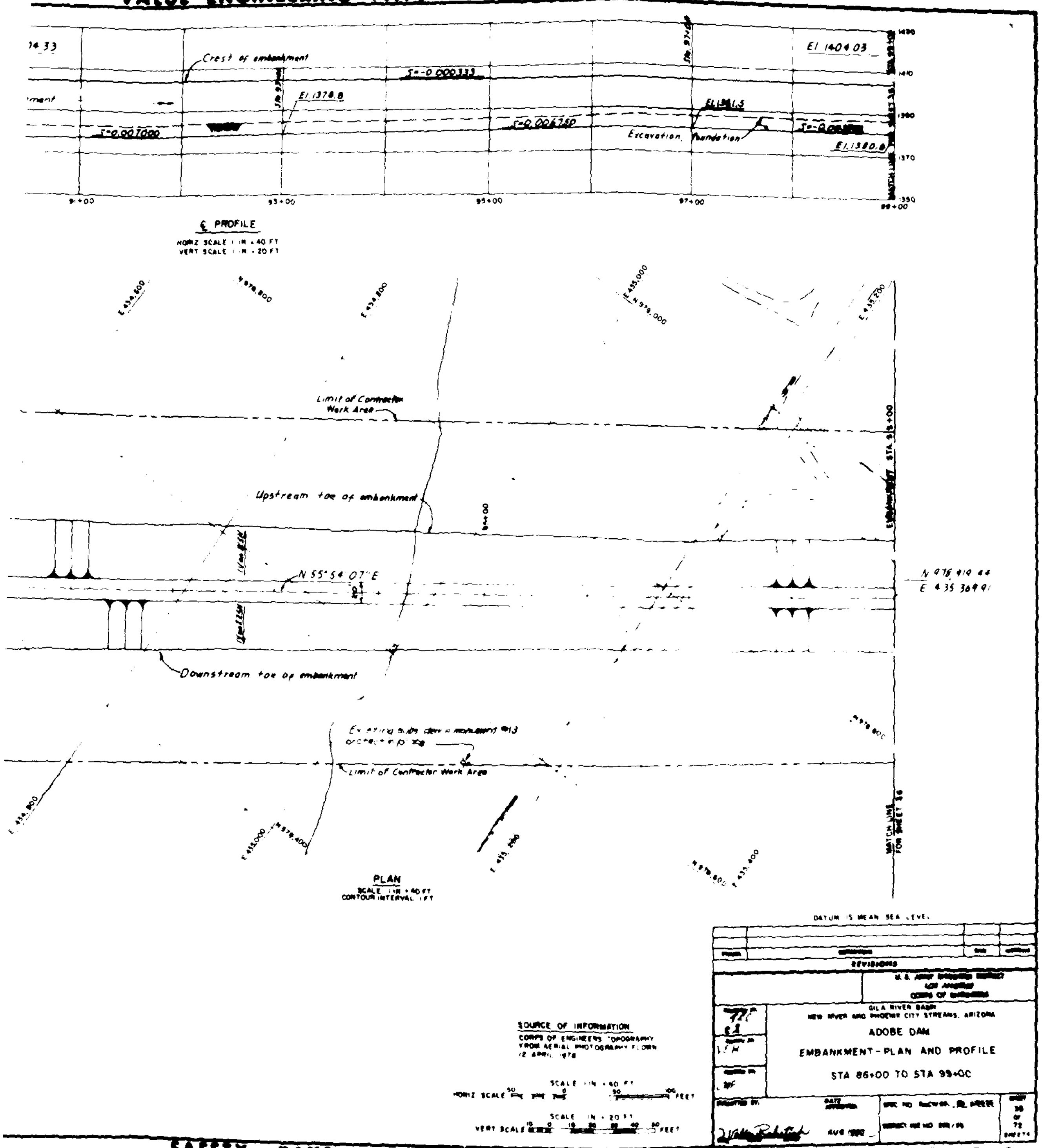
SAFETY PAYS

PLATE 18

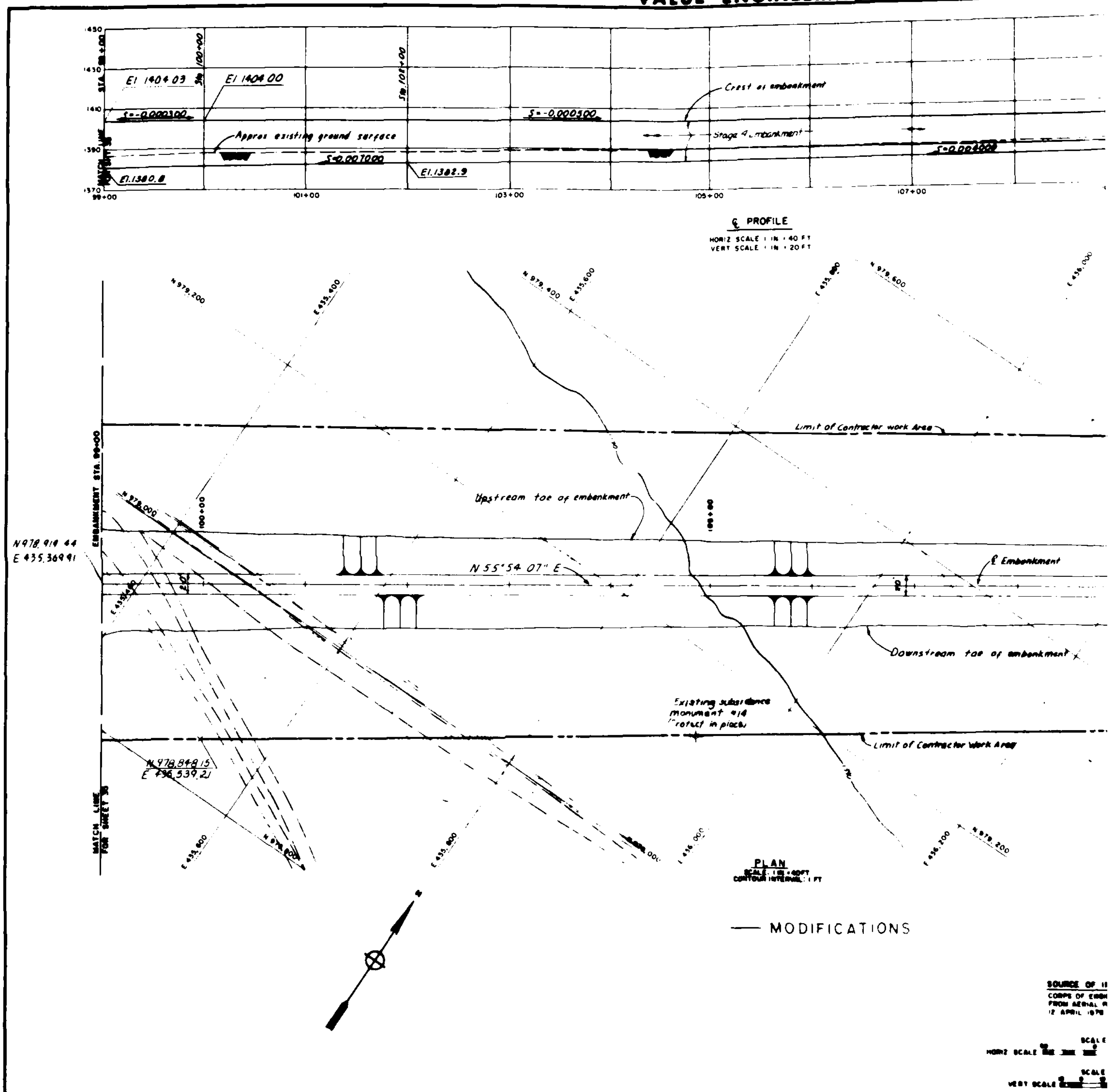
VALUE ENGINEERING PAYS



SAFETY PAYS

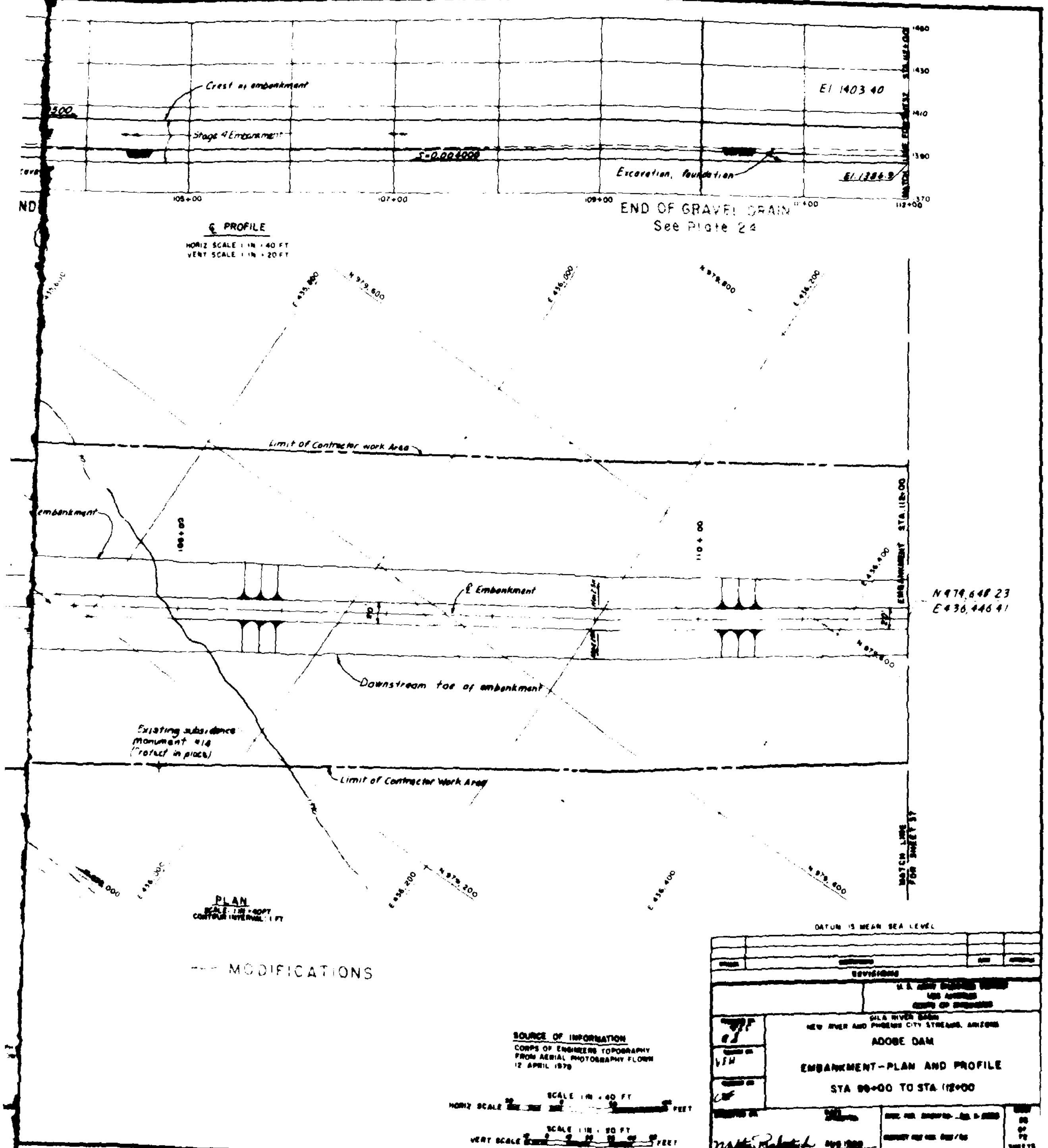

Crest of embankment
El 1404.03
El 1378.8
El 1380.8
Excavation, foundation
℄ PROFILE
HORIZ SCALE 1 IN = 40 FT
VERT SCALE 1 IN = 20 FT
Limit of Contractor Work Area
Upstream toe of embankment
N 55°54'07" E
N 976,919.44
E 435,369.91
Downstream toe of embankment
Limit of Contractor Work Area
PLAN
SCALE 1 IN = 40 FT
CONTOUR INTERVAL 1 FT
DATUM IS MEAN SEA LEVEL
REVISIONS
U.S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS
GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA
ADOBE DAM
EMBANKMENT - PLAN AND PROFILE
STA 86+00 TO STA 99+00
SOURCE OF INFORMATION
CORPS OF ENGINEERS TOPOGRAPHY FROM AERIAL PHOTOGRAPHY FLOWN 12 APRIL 1978
SCALE 1 IN = 40 FT
HORIZ SCALE FEET
SCALE 1 IN = 20 FT
VERT SCALE FEET
AUG 1980

VALUE ENGINEERING PAYS



SAFETY PAYS

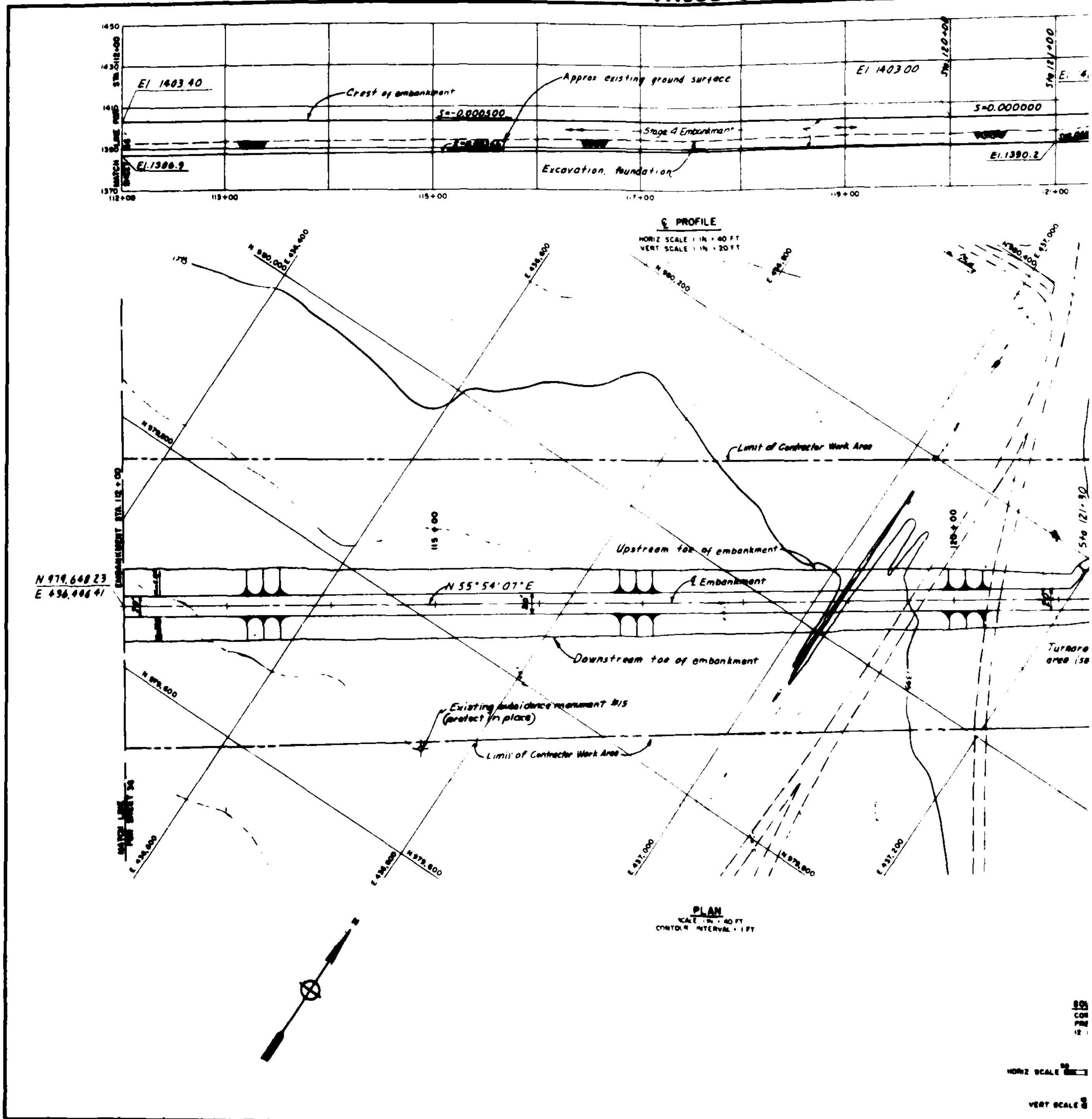
VALUE ENGINEERING PAYS



SAFETY PAYS

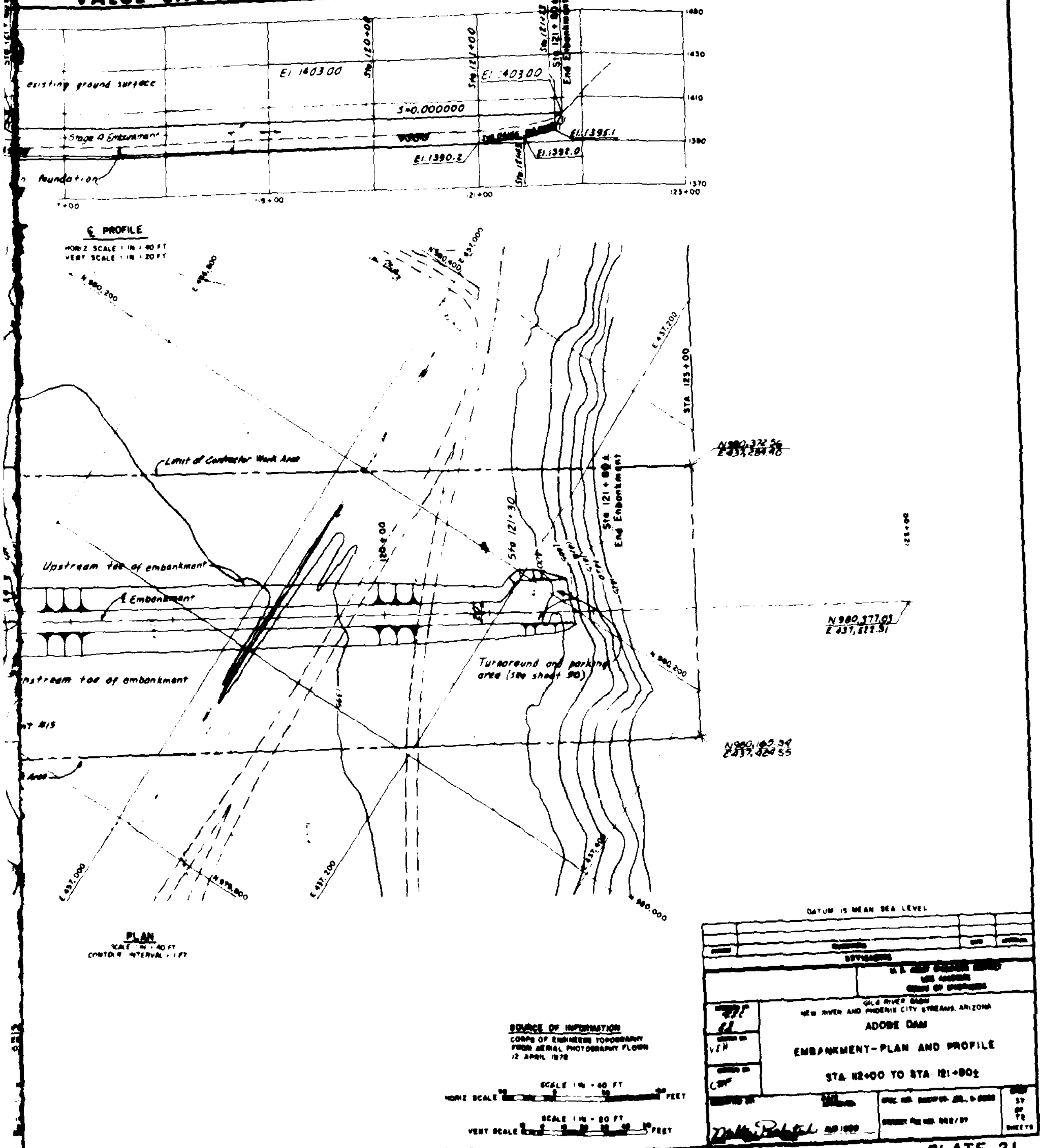
PLATE 20

VALUE ENGINEERING PAYS



SAFETY PAYS

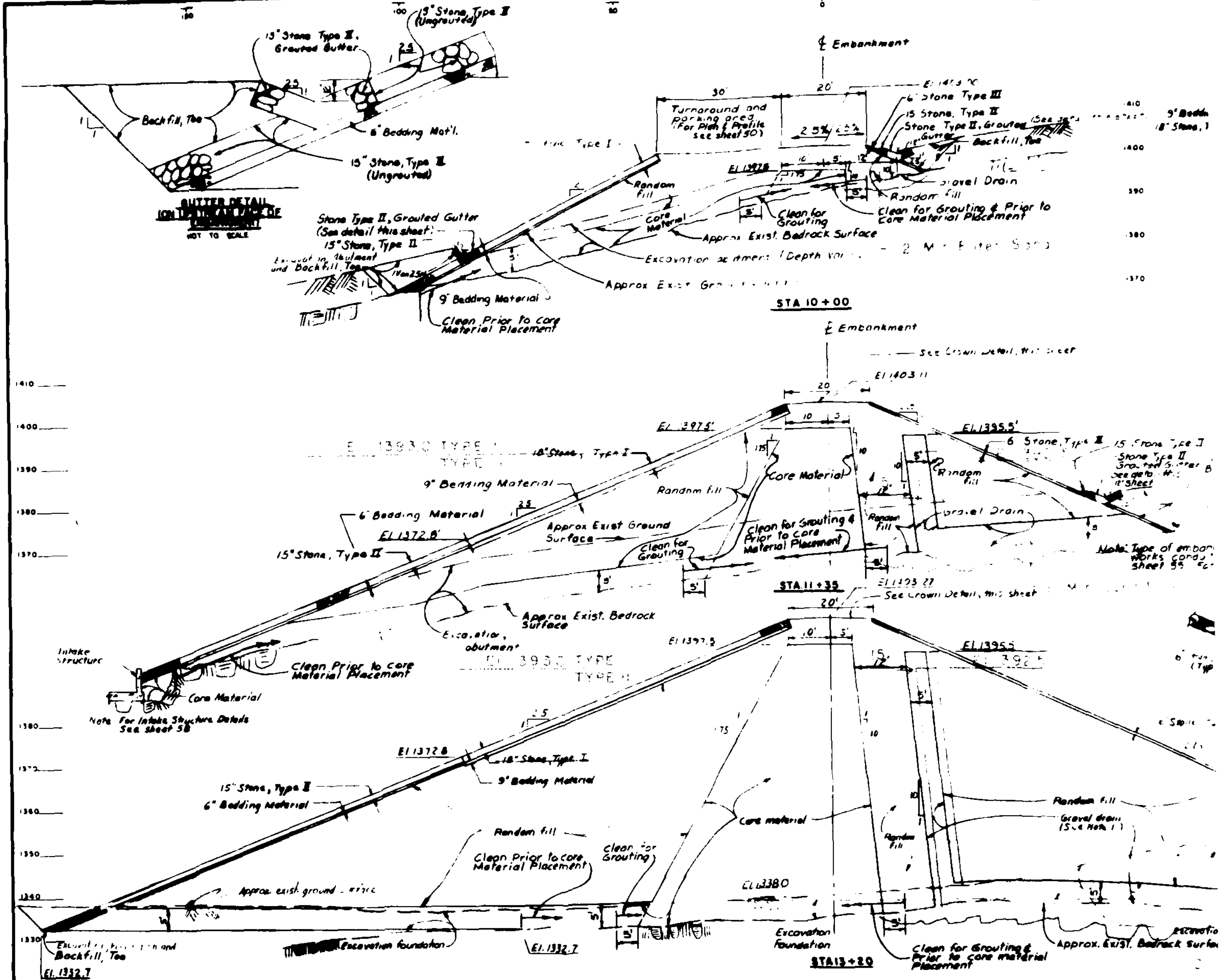
VALUE ENGINEERING PAYS



SAFETY PAYS

PLATE 21

VALUE ENGINEERING PAYS



GENERAL NOTES:

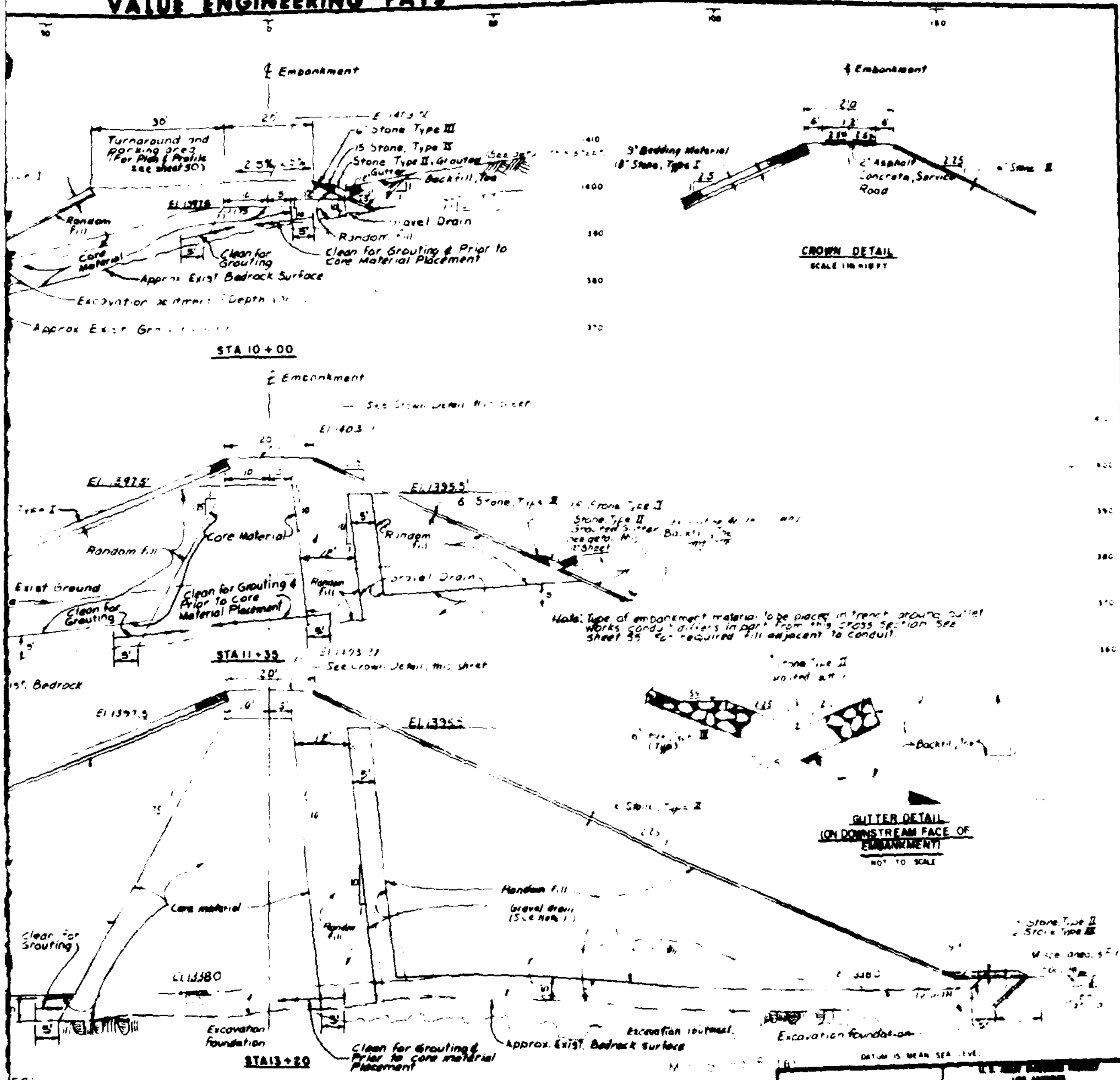
1. Place 5.0 ft thick gravel drain on Foundation from Sta. 9+60± to Sta 13+20. From Sta. 13+20 to Sta. 85+30 place 3.0 ft thick gravel drain on Foundation.
2. For Plan and Profile of Embankment, see sheets 25 thru sheet 37.
3. Esthetic Treatment Fill on slopes not shown; see sheets 47 thru 49.
4. For Plan of Grouted Gutters, see sheet 29.
5. 12" Filter material & 15" Stone, Type II, used for downstream toe protection is to run from Sta. 12+96 to Sta. 85+30.
6. Views of cross sections are looking eastward toward increasing stations.
7. Minimum widths of 5 ft. between Sta. 10+00± and Sta. 85+30 and 3 ft. between Sta. 85+30 and Sta. 121+10 are required for the inclined (1 vertical on 10 horizontal) portion of the gravel drain. The widths may be increased for the Contractor's convenience, but at no additional costs to the Federal government.

MODIFICATIONS

VERT SCALE 1 IN = 10 FT
HORIZ SCALE 1 IN = 10 FT

SAFETY PAYS

VALUE ENGINEERING PAYS



ES:

Place 5.0 ft thick gravel drain on foundation from Sta 9+60± to Sta 13+20. From Sta 13+20 to Sta 85+90 place 3.0 ft thick gravel drain on foundation.

For Plan and Profile of Embankment, see Sheets 29 thru sheet 37.

Esthetic Treatment Fill on slopes not shown; see sheets 47 thru 49.

For Plan of Grouted Gutters, see sheet 29.

2" Filter material & 15" Stone, Type II, used for downstream toe protection is to run from Sta 12+96 to Sta 85+90.

Views of cross sections are looking westward toward increasing stations.

Minimum width of 5 ft. between Sta 10+00± and Sta 85+90 and 3 ft. between Sta 85+90 and Sta 121+10 are required for the inclined (vertical on 10 horizontal) portion of the gravel drain. The width may be increased for the Contractor's Convenience, but at no additional costs to the Federal government.

MODIFICATIONS

VERT SCALE 1 IN = 10 FT
HORIZ SCALE 1 IN = 10 FT

U.S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

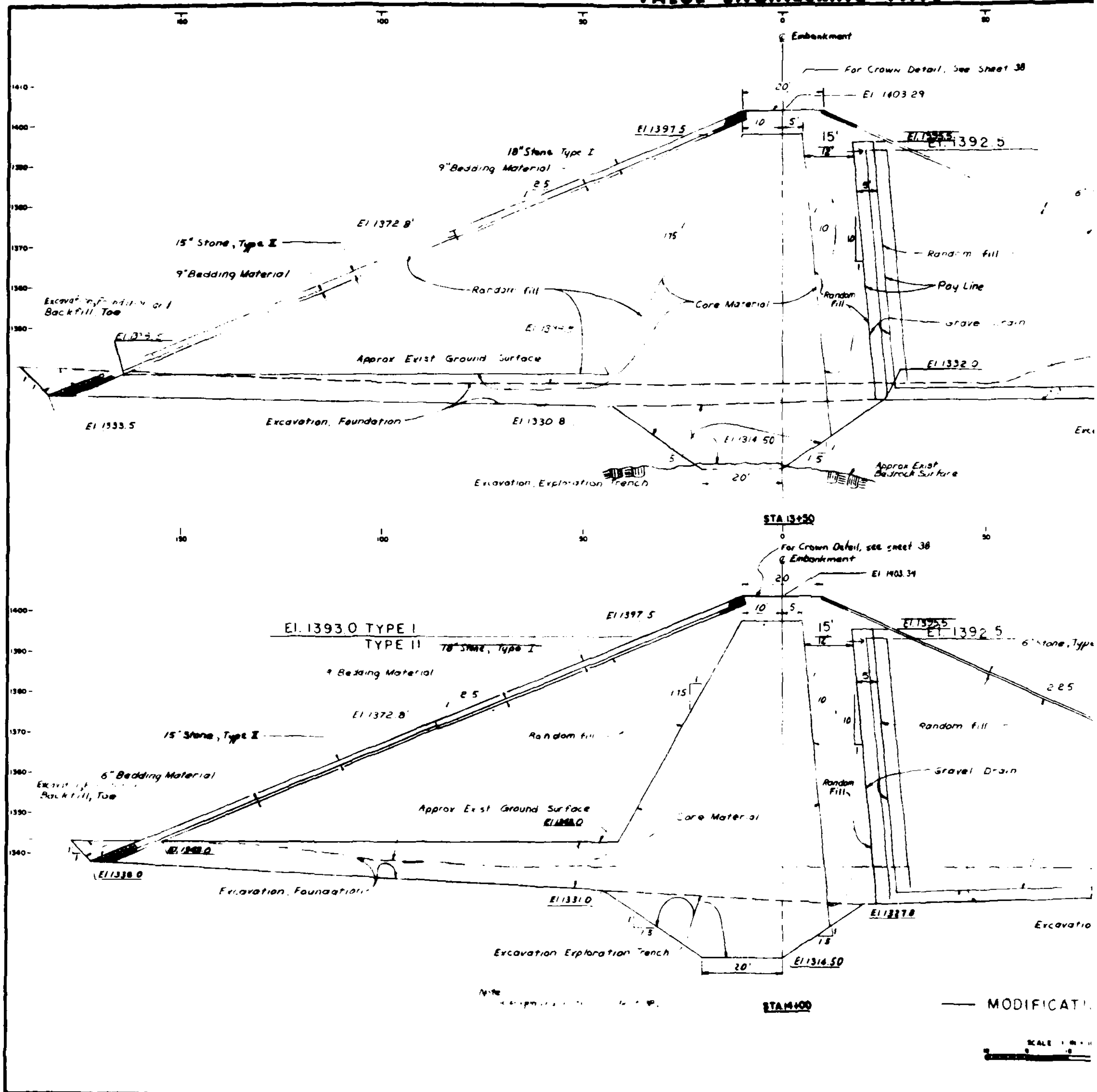
GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA

ADOBE DAM
EMBANKMENT
CROSS SECTIONS
ABUTMENT

SAFETY PAYS

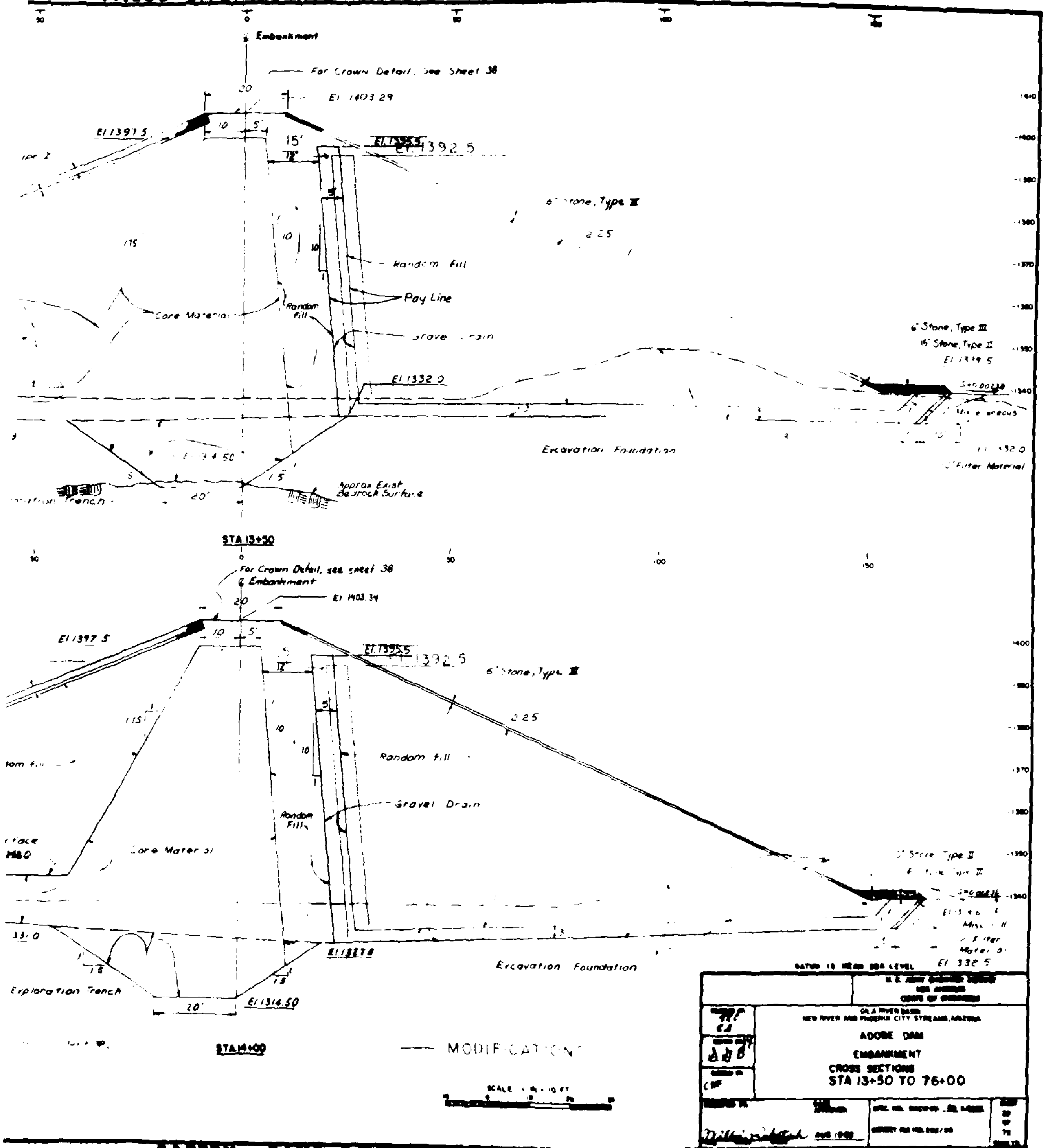
PLATE 22

VALUE ENGINEERING PAYS



SAFETY PAYS

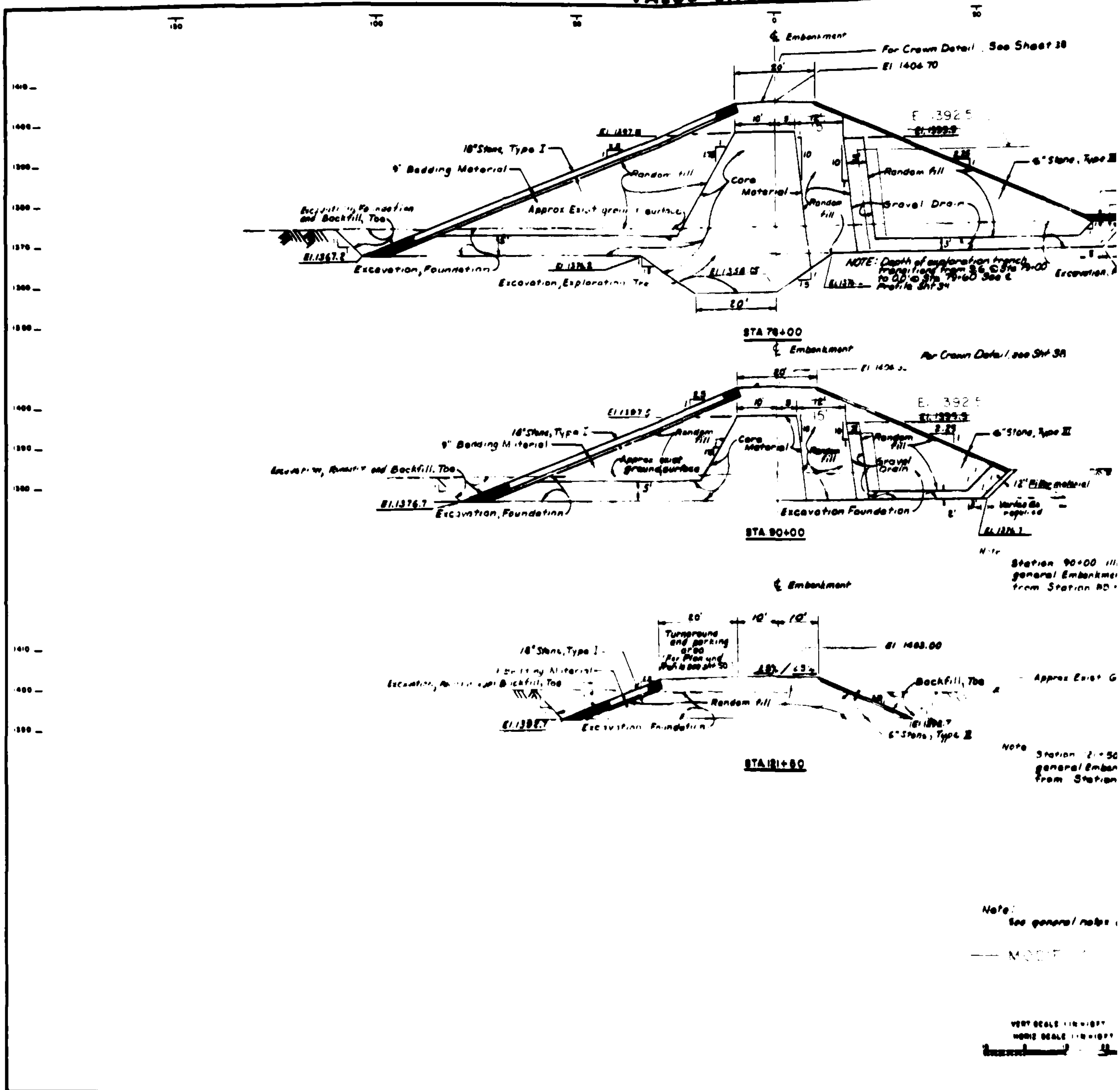
VALUE ENGINEERING PAYS



SAFETY PAYS

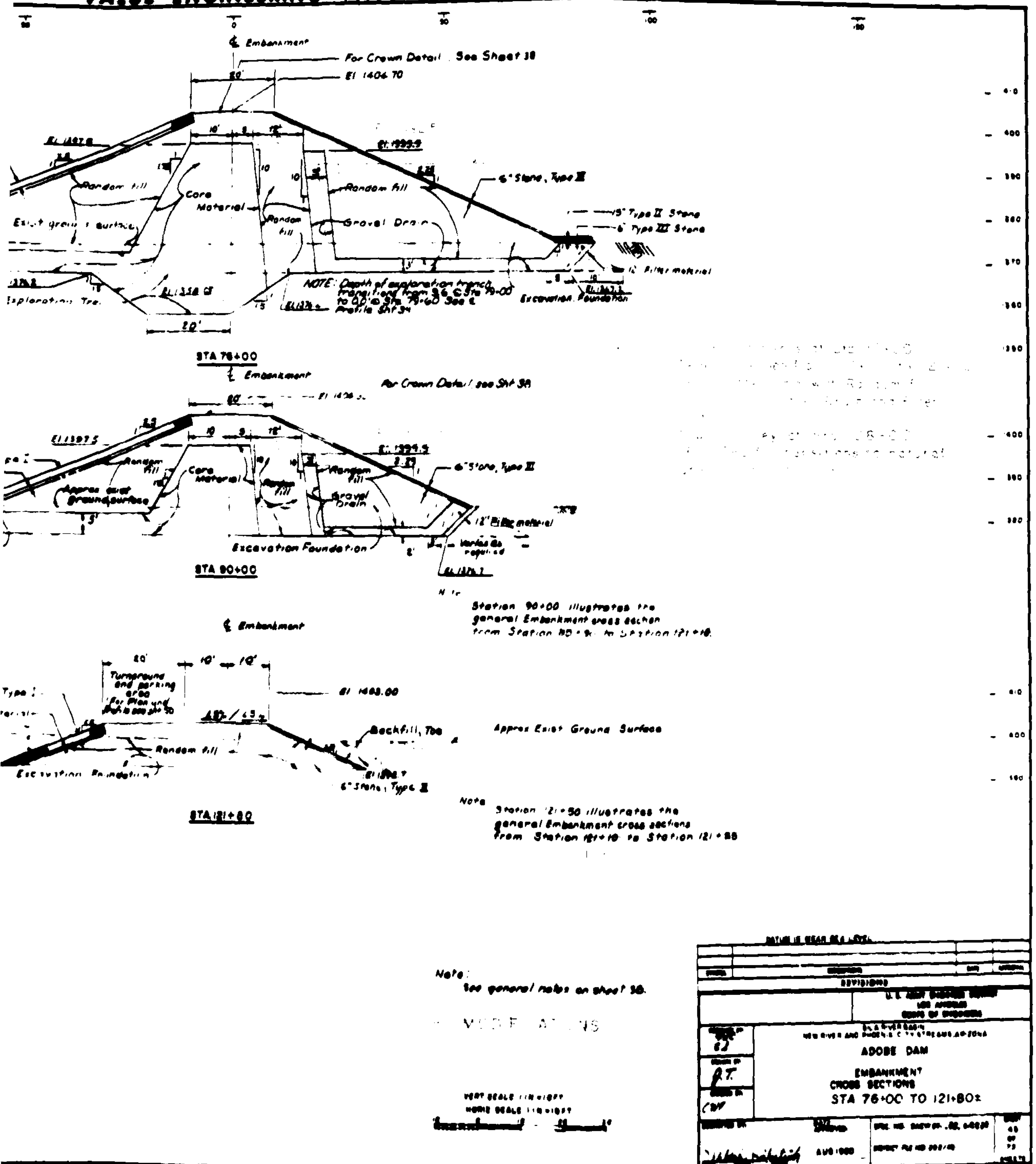
PLATE 23

VALUE ENGINEERING PAYS



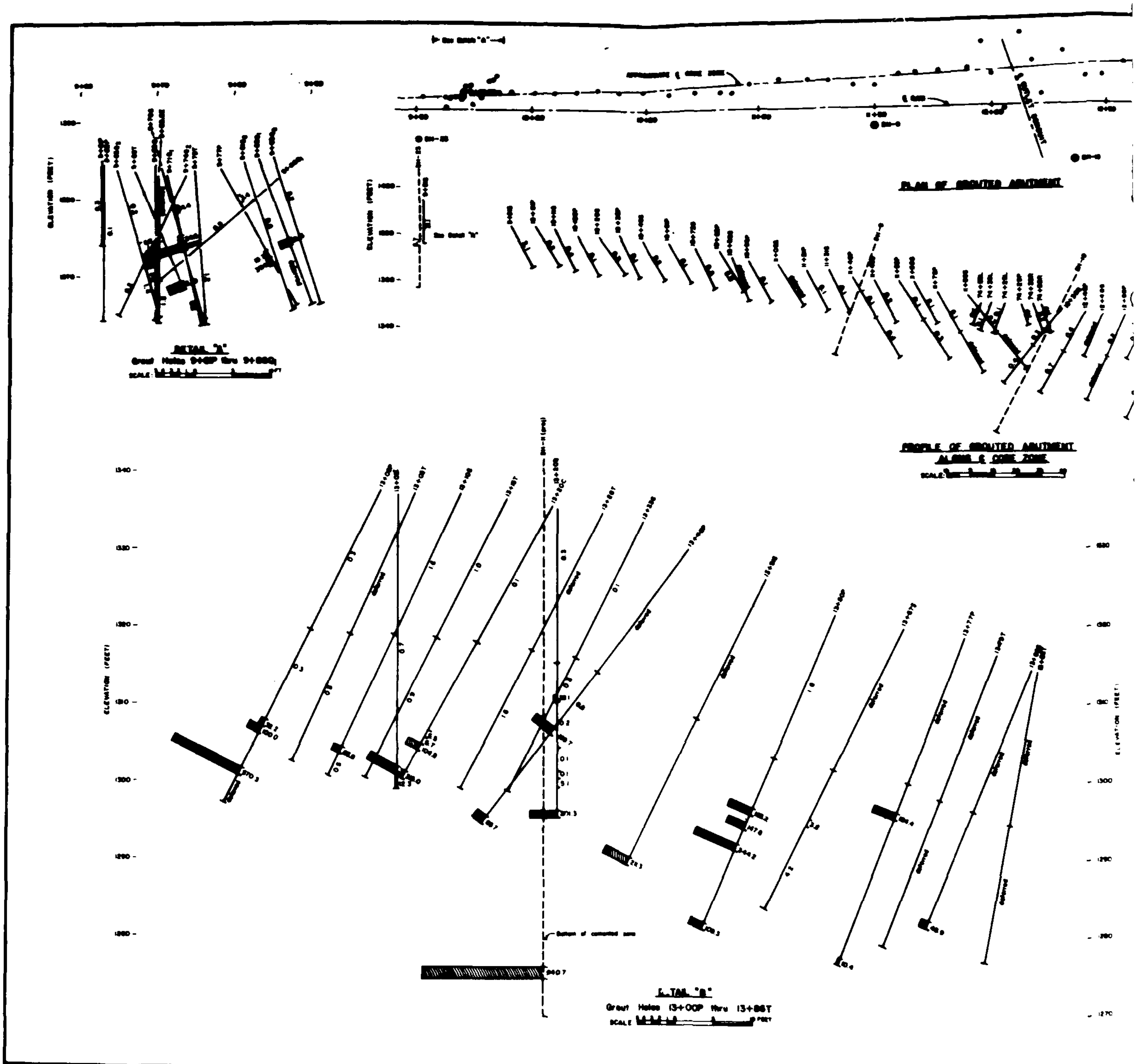
SAFETY PAYS

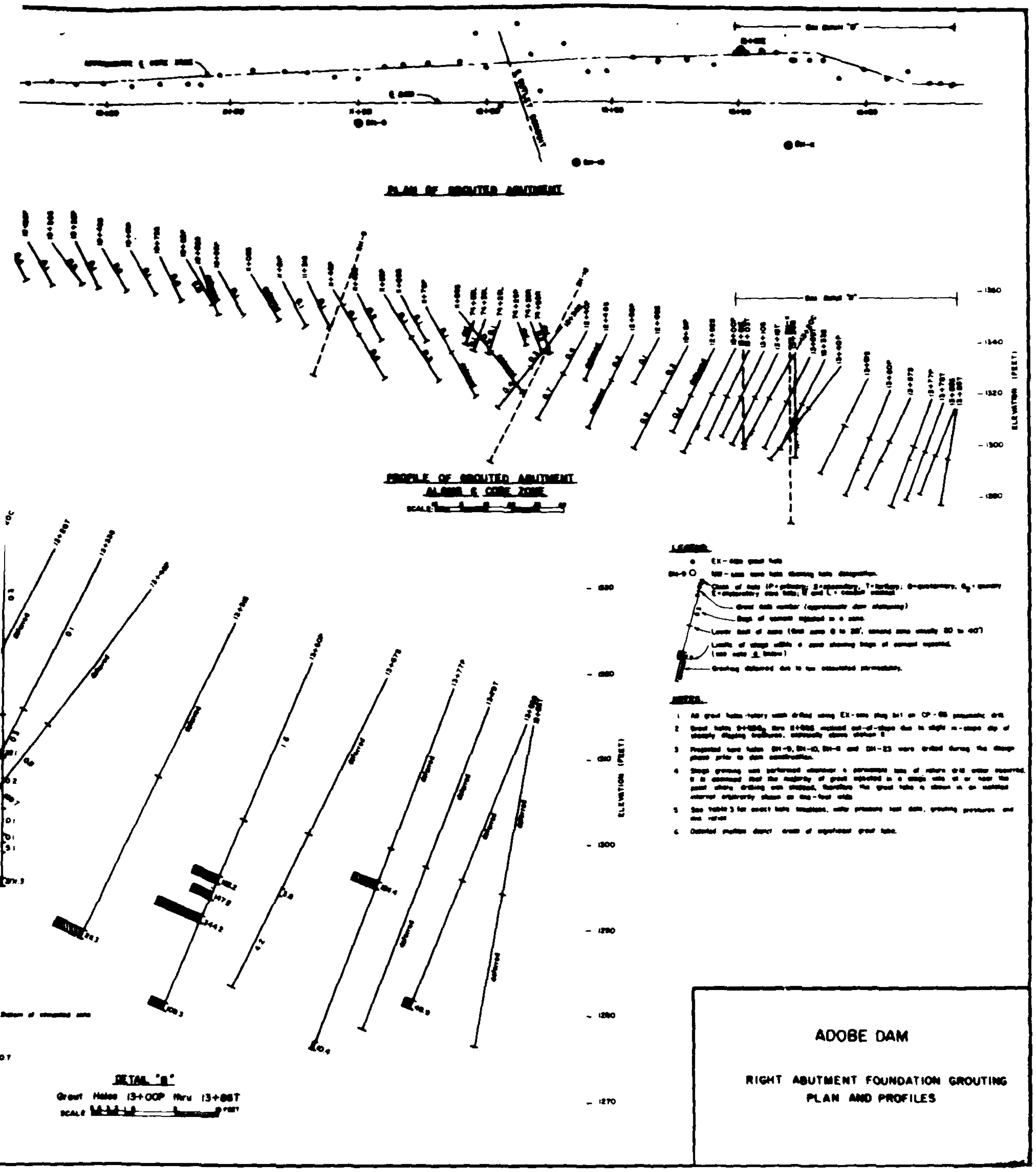
VALUE ENGINEERING PAYS



SAFETY PAYS

PLATE 24

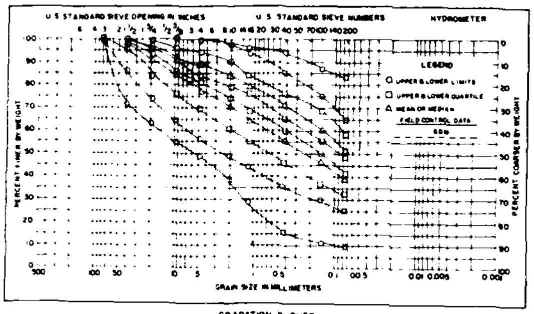

PLAN OF GROUTED ABUTMENT
PROFILE OF GROUTED ABUTMENT ALONG ℄ CORE ZONE
DETAIL "A"
Grout Holes 9+00P thru 9+00Q
DETAIL "B"
Grout Holes 13+00P thru 13+86T
ELEVATION (FEET)
Bottom of compacted zone



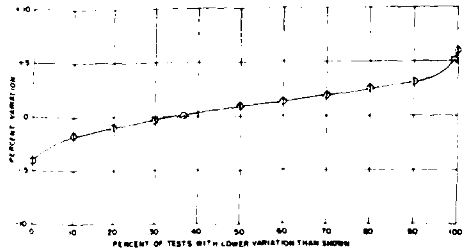
ADOBE DAM

RIGHT ABUTMENT FOUNDATION GROUTING
PLAN AND PROFILES

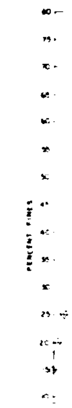
PLATE 25

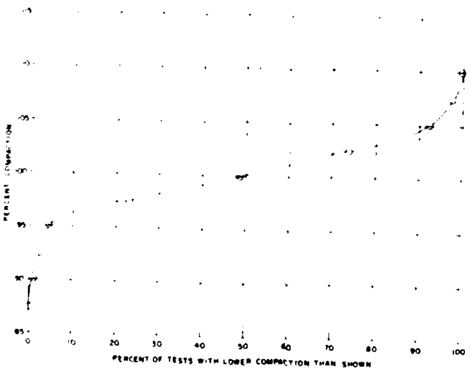


GRADATION CURVES

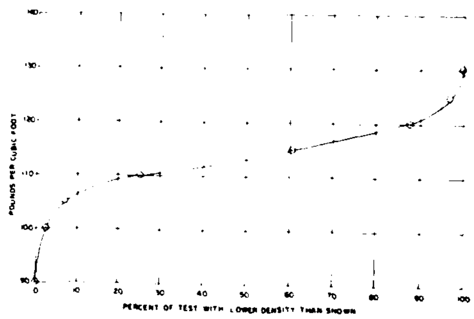


MOISTURE CONTENT VARIATION FROM LABORATORY OPTIMUM

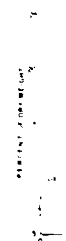


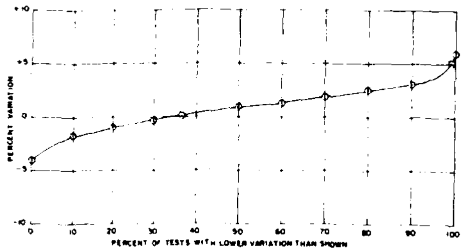


COMPACTION

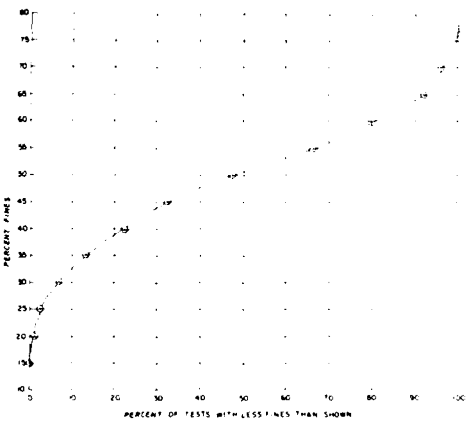


UNIT DRY WEIGHT

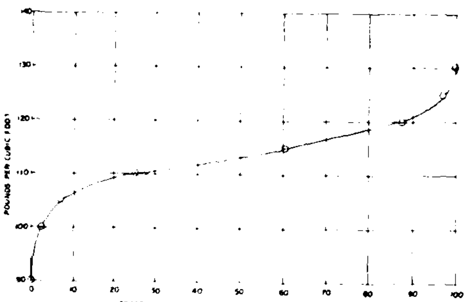




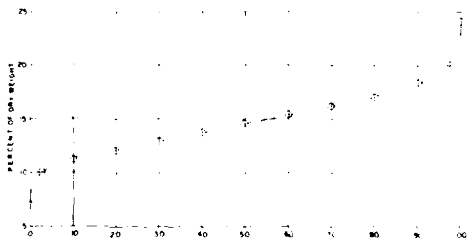
MOISTURE CONTENT VARIATION FROM LABORATORY OPTIMUM



GRADATION



UNIT DRY WEIGHT



MOISTURE CONTENT

SYMBOL	DESCRIPTIONS	DATE	APPROVAL
REVISIONS			

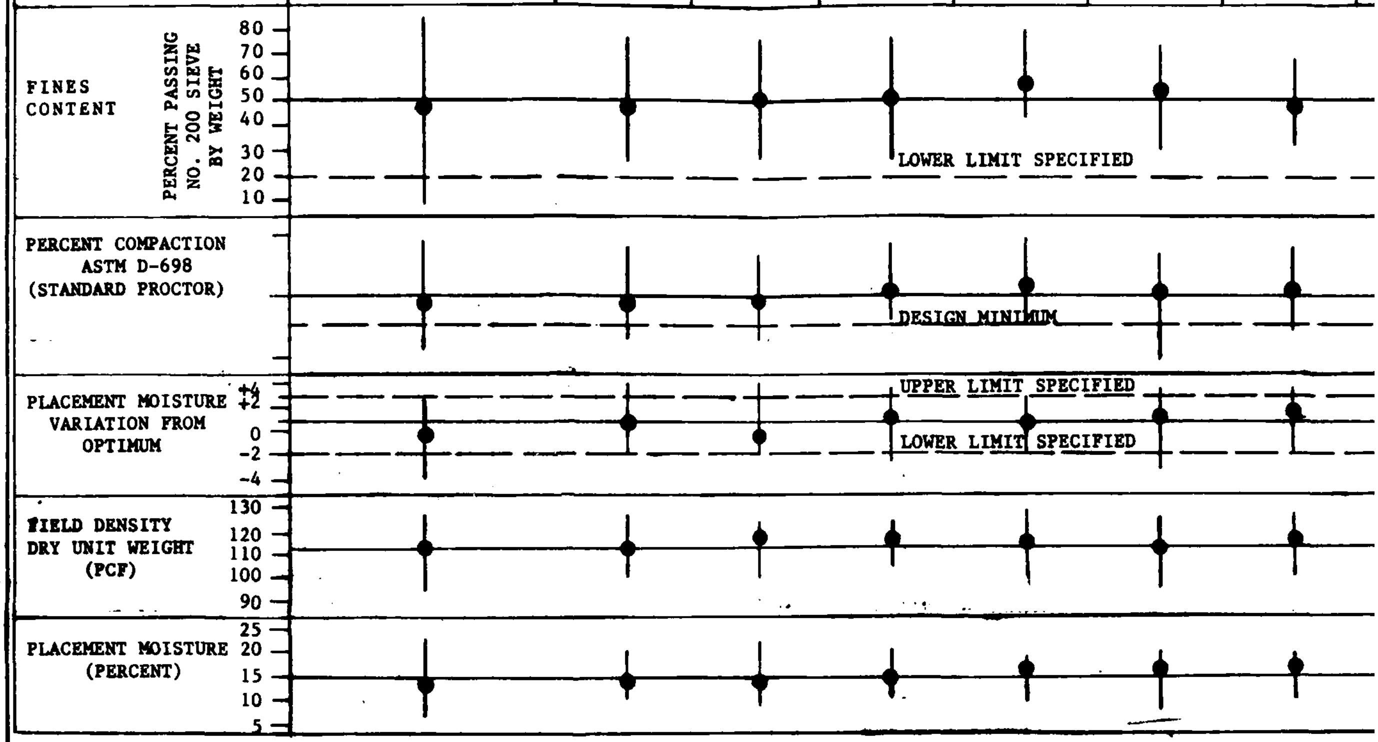
	U.S. ARMY ENGINEER DISTRICT LOS ANGELES CORPS OF ENGINEERS
DESIGNED BY.	GILA RIVER BASIN NEW RIVER AND PHOENIX CITY STREAMS ADOBE DAM CORE MATERIAL FIELD CONTROL DATA
DRAWN BY.	
CHECKED BY.	
SUBMITTED BY. DATE APPROVED	SPEC NO DACW09- . . . . -B- . . . DISTRICT FILE NO
	SHEET

PLATE 20

YEAR 1981	MONTH	MARCH-APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	N

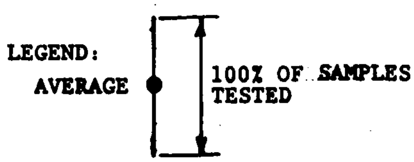
CONSTRUCTION CONTROL DATA

TESTS	91	41	27	22	18	31	19	



PLACEMENT DATA

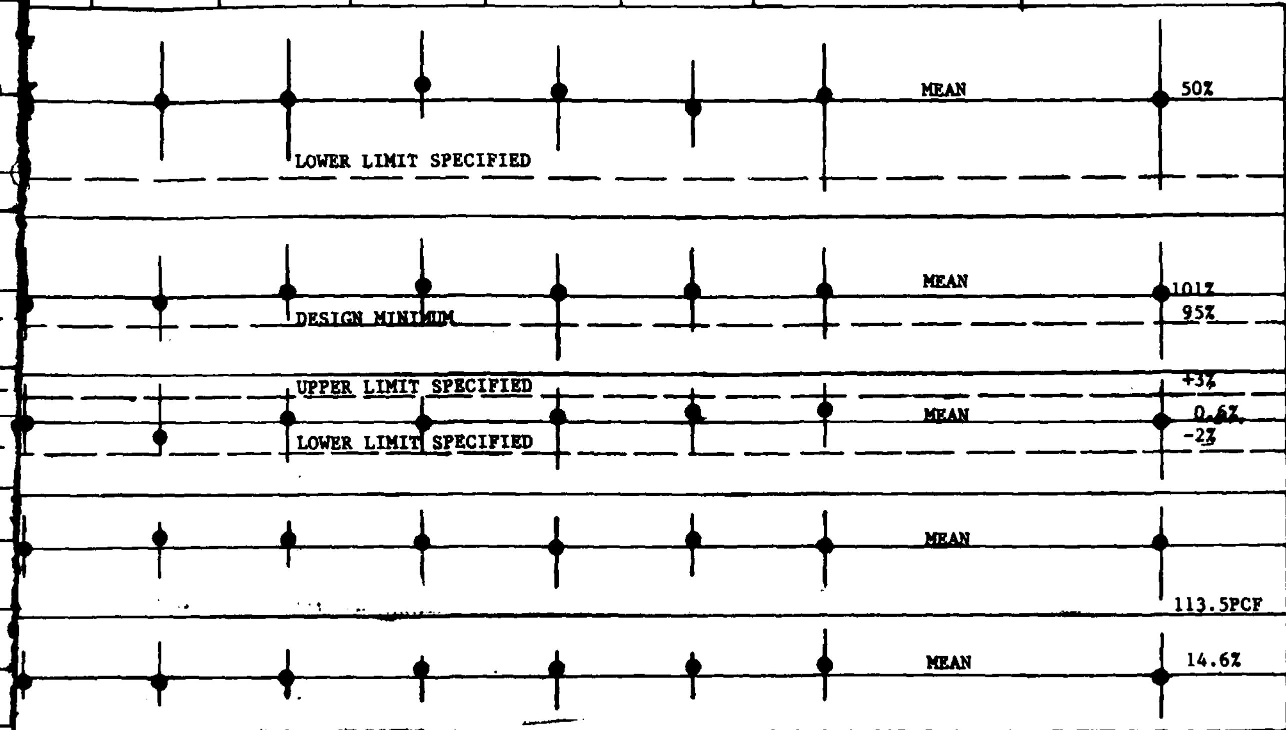
PLACEMENT STATIONS	21+00 – 120+60	34+27-[illegible]+07	[illegible]	34+27-70+07	[illegible]	[illegible]	24+21-[illegible]	
PLACEMENT ELEVATIONS	1323 – 1397	1342 – [illegible]	1352 – 1304	1342 – [illegible]	[illegible] – 1373	[illegible] – [illegible]	[illegible] – [illegible]	
PLACEMENT DAYS	46	20	22	22	21	21	20	
VOLUME PLACED (CY)	225,[illegible]	107,530	29,588	32,137	45,[illegible]	34,118	33,270	
AVERAGE DAILY PLACEMENT RATE (CY)	4905	5377	1345	[illegible]	2146	1625	1604	



	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER-DECEMBER	SUMMARY (MEAN)

CONSTRUCTION CONTROL DATA

	27	22	18	31	19	96	345



PLACEMENT DATA

-70+67	80+00 80+45	34+27-70+07	30+05-63+00	23-22-61-38	24+21-63+00	9+71 - 85+40	
-1306	1302-1304	1342-1306	1302-1373	1300-1306	1305-1302	1322-1307	
30	22	22	21	21	20	30	211
,530	29,500	32,137	45,073	34,110	33,270	100,218	887,853
77	1345	[illegible]	2140	1025	1004	4100	3280

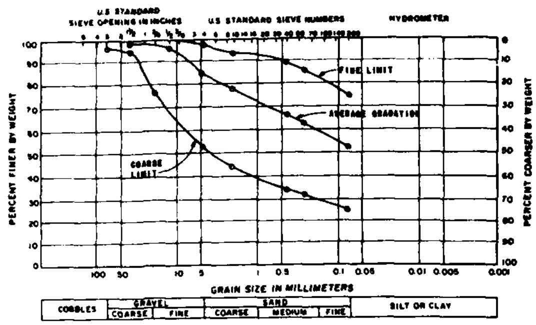
100% OF SAMPLES TESTED

GILA RIVER BASIN, NEW RIVER AND PHOENIX CITY STREAMS

ADOBE DAM
CORE MATERIAL
FIELD CONTROL AND
PLACEMENT DATA

US ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

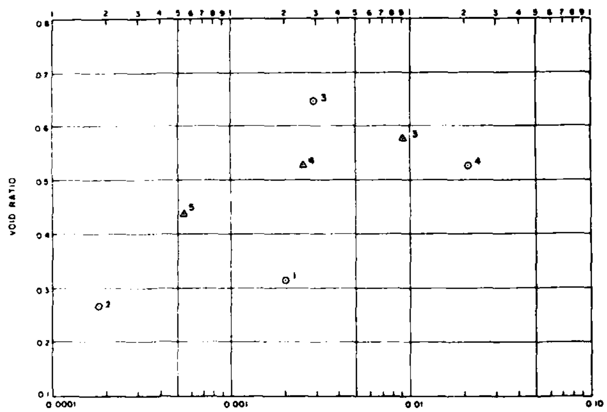
PLATE 27



GRADATION CURVES

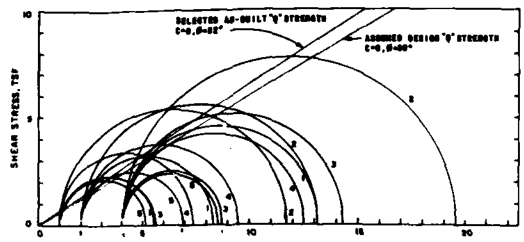
NO.	DIVIDED SAMPLE NO.	MECHANICAL ANALYSIS			ATTERBERG LIMITS	
		4	SAND	200	LL	PI
1	75100	8	39	53	35	14
2	[illegible]	11	[illegible]	[illegible]	[illegible]	15
3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5	[illegible]	6	[illegible]	[illegible]	[illegible]	[illegible]

○ HORIZONTAL PERMEABILITY
△ VERTICAL PERMEABILITY
ALL SAMPLES UNDISTURBED



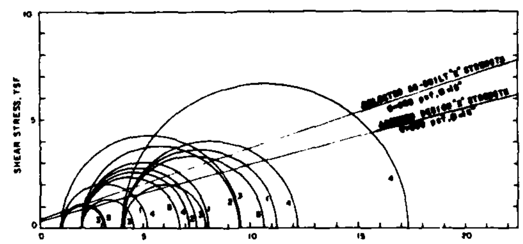
PERMEABILITY TEST DATA

NO.	DIVIDED SAMPLE NO.	SOIL CLASS SYMBOL	TYPE OF SAMPLE	PROPERTIES: INITIAL DRY DENSITY (PCF)	INITIAL MOISTURE CONTENT (%)	INITIAL SATURATION (%)	BEFORE SHEAR DRY DENSITY (PCF)	BEFORE SHEAR MOISTURE CONTENT (%)	BEFORE SHEAR SATURATION (%)
1	[illegible]	CL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2	[illegible]	SC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3	[illegible]	SC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	61-71
4	77001	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5	[illegible]	CL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]



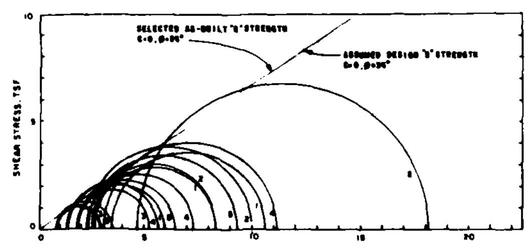
"Q" SHEAR STRENGTH

NO.	DIVIDED SAMPLE NO.	SOIL CLASS SYMBOL	TYPE OF SAMPLE	PROPERTIES: INITIAL DRY DENSITY (PCF)	INITIAL MOISTURE CONTENT (%)	INITIAL SATURATION (%)	BEFORE SHEAR DRY DENSITY (PCF)	BEFORE SHEAR MOISTURE CONTENT (%)	BEFORE SHEAR SATURATION (%)
1	75100	CL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	100
2	[illegible]	SC	[illegible]	[illegible]	11.5-11.8	[illegible]	[illegible]	[illegible]	100
3	[illegible]	SC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4	77001	SC	[illegible]	110.2-111.6	[illegible]	91-97	[illegible]	[illegible]	100
5	[illegible]	CL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	100

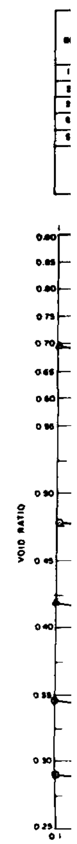


"R" SHEAR STRENGTH

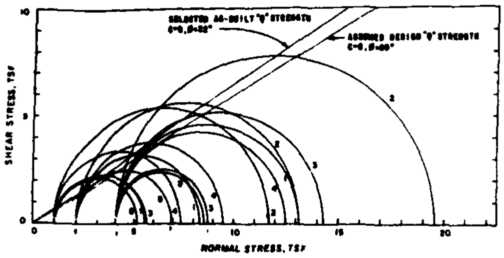
NO.	DIVIDED SAMPLE NO.	σ3 TOTAL NORMAL STRESS (TSF)	σ3 EFFECTIVE NORMAL STRESS (TSF)
1	[illegible]	1.0,2.0,4.0	[illegible]
2	[illegible]	1.0,2.0,4.0	[illegible]
3	[illegible]	1.0,2.0,4.0	[illegible]
4	[illegible]	1.0,2.0,4.0	[illegible]
5	[illegible]	1.0,2.0,4.0	[illegible]



"S" SHEAR STRENGTH

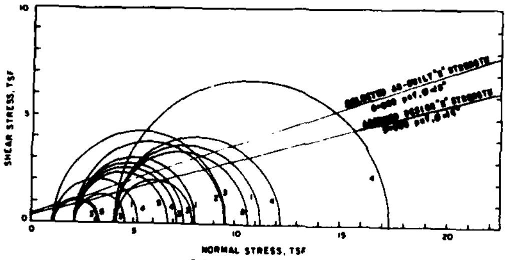


NO.	[illegible] SAMPLE NO.	SOIL CLASS SYMBOL	TYPE OF SAMPLE	PROPERTIES					
				INITIAL			BEFORE SHEAR		
				DRY DENSITY (PCF)	MOISTURE CONTENT (%)	SATURATION (%)	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	SATURATION (%)
1	[illegible]	CL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2	[illegible]	SC	[illegible]	[illegible]	[illegible]-11.0	[illegible]	[illegible]	[illegible]-11.2	[illegible]
3	77000	SC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]-103.2	[illegible]-17.0	61-71
4	77001	SC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]-112.6	[illegible]	[illegible]
5	[illegible]	CL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]



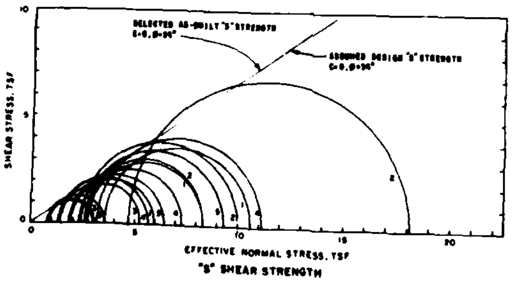
"Q" SHEAR STRENGTH

NO.	[illegible] SAMPLE NO.	SOIL CLASS SYMBOL	TYPE OF SAMPLE	PROPERTIES					
				INITIAL			BEFORE SHEAR		
				DRY DENSITY (PCF)	MOISTURE CONTENT (%)	SATURATION (%)	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	SATURATION (%)
1	[illegible]	CL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	100
2	[illegible]	SC	[illegible]	[illegible]	11.5-11.8	[illegible]	[illegible]	[illegible]	100
3	[illegible]	SC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] - 100
4	[illegible]	SC	[illegible]	110.2-111.5	[illegible]	81 - 87	[illegible]	[illegible]	100
5	[illegible]	CL	[illegible]	[illegible]-111.2	[illegible]	[illegible]	[illegible]	[illegible]	100



"R" SHEAR STRENGTH

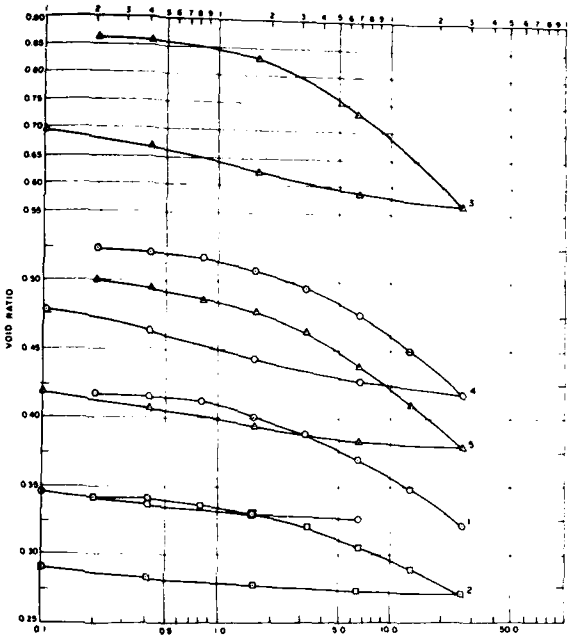
NO.	[illegible] SAMPLE NO.	TOTAL NORMAL STRESS (TSF)	EFFECTIVE NORMAL STRESS (TSF)
1	[illegible]	[illegible]	[illegible]
2	[illegible]	[illegible]	[illegible]
3	[illegible]	[illegible]	[illegible]
4	[illegible]	[illegible]	[illegible]
5	[illegible]	[illegible]	[illegible]



"S" SHEAR STRENGTH

NO.	DIVISION SAMPLE NO.	SOIL CLASS SYMBOL	TYPE OF SAMPLE	PROPERTIES							REMARKS
				BEFORE TEST				AFTER TEST			
				DRY DENSITY (PCF)	MOISTURE CONTENT (%)	VOID RATIO	SATURATION (%)	MOISTURE CONTENT (%)	VOID RATIO	SATURATION (%)	
1	[illegible]	CL	UNDISTURBED	120.0	12.0	[illegible]	[illegible]	12.6	[illegible]	[illegible]	NOTE 1
2	[illegible]	CL	UNDISTURBED	127.5	10.0	[illegible]	87	10.0	[illegible]	100	NOTE 1&2
3	77000	CL	UNDISTURBED	91.0	[illegible]	[illegible]	72	[illegible]	0.786	100	NOTE 1,2&4
4	77001	SC	UNDISTURBED	111.0	17.0	[illegible]	91	18.5	[illegible]	100	NOTE 1&2
5	[illegible]	CL	UNDISTURBED	112.2	15.0	[illegible]	96	15.4	[illegible]	[illegible]	NOTE 1&2

NOTES:
1. TEST SPECIMEN DIAMETER [illegible], HEIGHT 1.00"
2. [illegible] AT [illegible] TSF LOAD
3. [illegible] AT 1.00 TSF LOAD
4. NOT REPRESENTATIVE OF FIELD DENSITY OR MOISTURE (SEE FIELD CONTROL [illegible])



CONSOLIDATION TEST DATA

SYMBOL	DESCRIPTIONS	DATE	APPROVAL

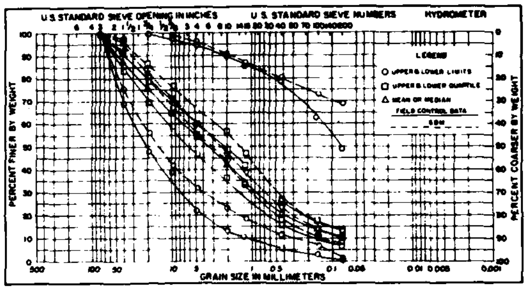
REVISIONS

U. S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

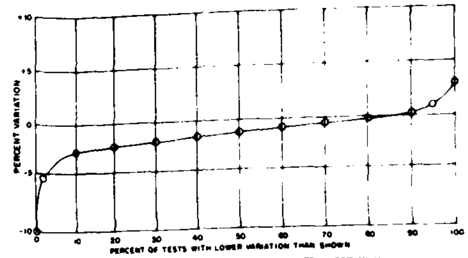
GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS

ADOBE DAM
CORE MATERIAL
RECORD TEST RESULTS

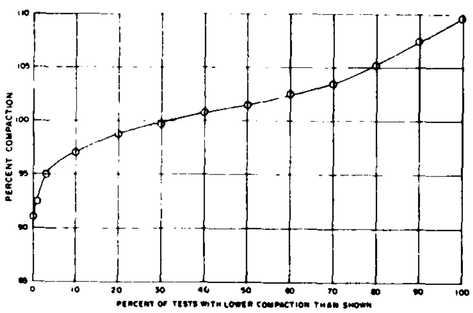
DESIGNED BY:
DRAWN BY: ЯBa
CHECKED BY:
SUBMITTED BY:
DATE APPROVED
SPEC NO. DACW09-____-B-____
SHEET
DISTRICT FILE NO.



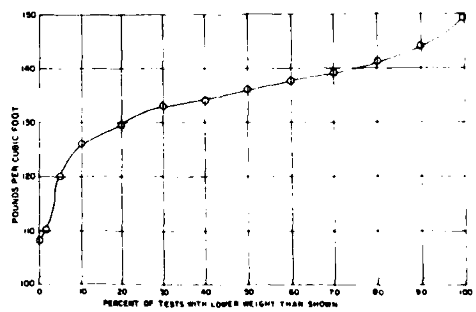
GRADATION CURVES



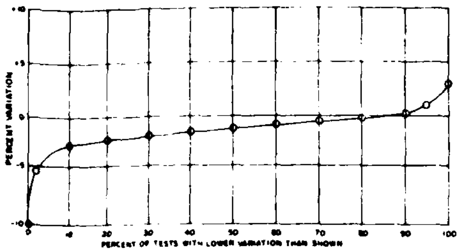
MOISTURE CONTENT VARIATION FROM LABORATORY OPTIMUM



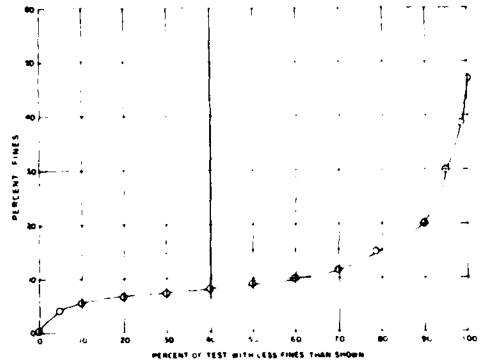
COMPACTION



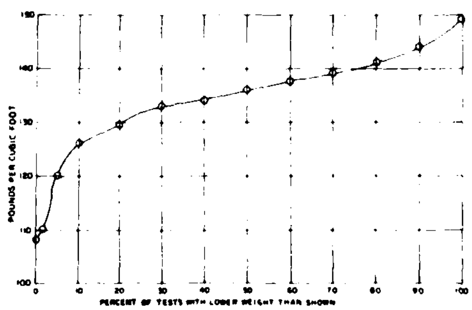
UNIT DRY WEIGHT



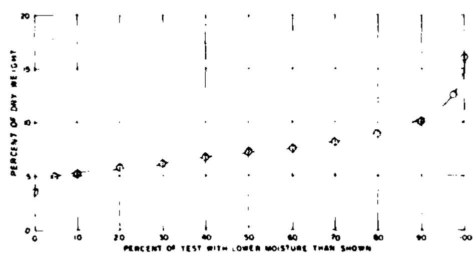
MOISTURE CONTENT VARIATION FROM LABORATORY OPTIMUM



FINES



UNIT DRY WEIGHT



MOISTURE CONTENT

SYMBOL	DESCRIPTIONS	DATE	APPROVAL

REVISIONS

U. S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

DESIGNED BY:

DRAWN BY:

CHECKED BY:

GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS

ADOBE DAM
RANDOM MATERIAL
FIELD CONTROL DATA

SUBMITTED BY: DATE APPROVED

SPEC NO. DACW 09- .... B- ....

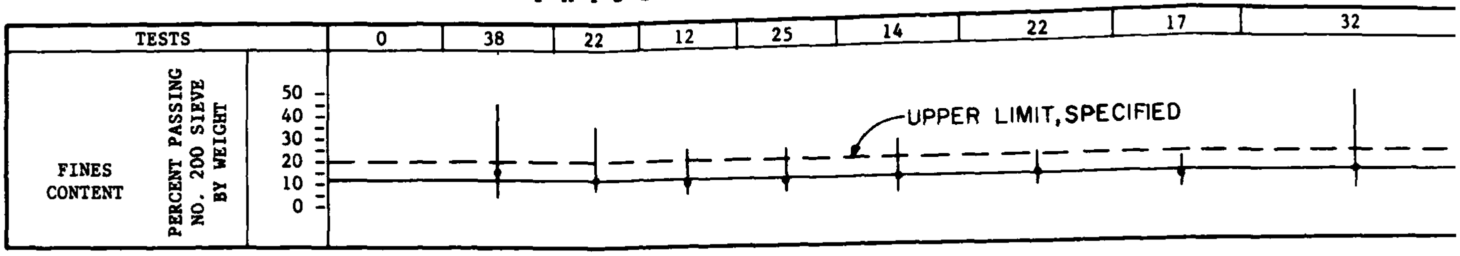
DISTRICT FILE NO.

SHEET

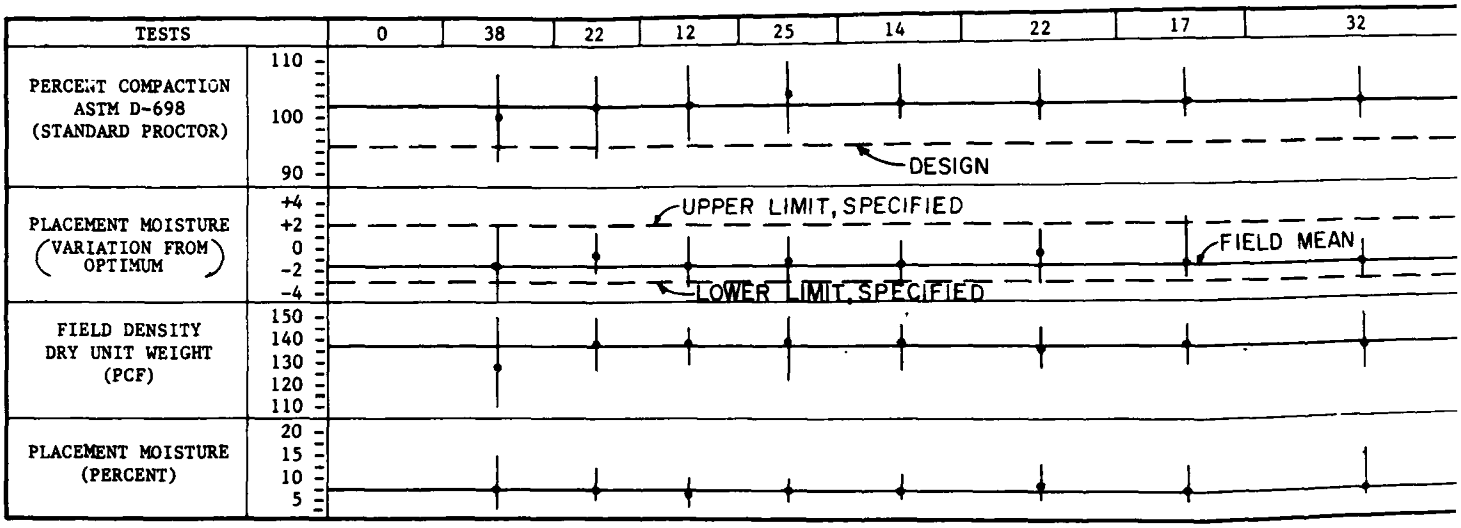
PLATE 29

YEAR 1981	MONTH	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER-DECEMBER

PHYSICAL PROPERTIES



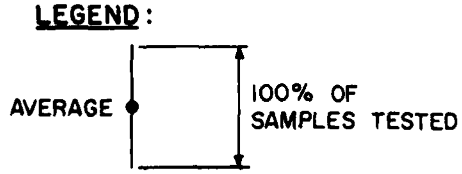
CONSTRUCTION CONTROL DATA



PLACEMENT DATA

	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER
PLACEMENT STATIONS	21+00-24+25	21+85-121+53	41+39-63+85	65+00-81+00	41+39-63+85	38+20-75+40	23+12-57+50	18+82-60+40
PLACEMENT ELEVATIONS		1304-1403	1351-1370	1368-1384	1351-1370	1348-1380	1360-1389	1367-1397
PLACEMENT DAYS	1	20	20	22	22	21	21	20
VOLUME PLACED (C.Y.)	2,800	253,624	53,672	113,028	241,906	107,630	82,239	152,514
AVERAGE DAILY PLACEMENT RATE (C.Y.)	2,800	12,681	2,684	5,138	10,996	8,125	3,916	7,626

LEGEND:



NEW RIVER

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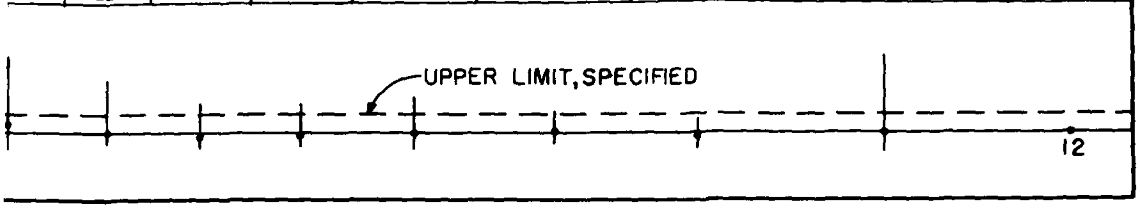
LC

...IL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER-DECEMBER	SUMMARY (MEAN)

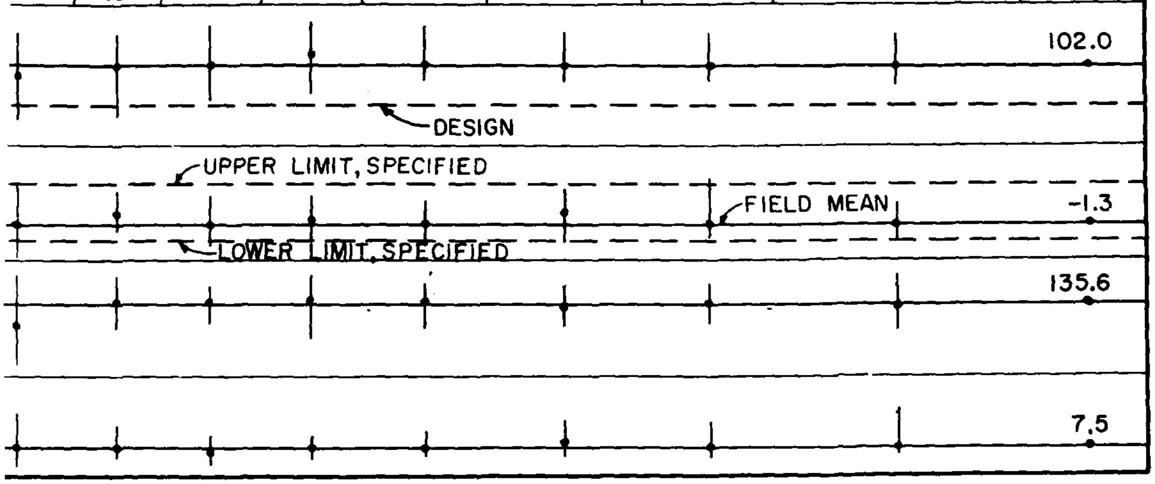
P H Y S I C A L   P R O P E R T I E S

3	22	12	25	14	22	17	32	182



...N S T R U C T I O N   C O N T R O L   D A T A

8	22	12	25	14	22	17	32	182



P L A C E M E N T   D A T A

APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER DECEMBER	SUMMARY
.+85-121+53	41+39-63+85	65+00-81+00	41+39-63+85	38+20-75+40	23+12-57+50	18+82-60+40	11+08-84+32	
1304-1403	1351-1370	1368-1384	1351-1370	1348-1380	1360-1389	1367-1397	1346-1402	
20	20	22	22	21	21	20	40	187
253,624	53,672	113,028	241,906	107,630	82,239	152,514	393,923	1,461,538
12,681	2,684	5.138	10,996	8.125	3,916	7,626	9.848	7,816

100% OF
SAMPLES TESTED

GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS

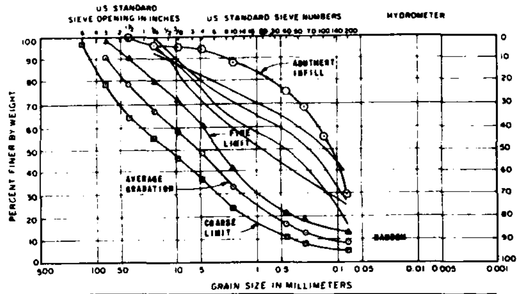
ADOBE DAM

RANDOM MATERIAL
FIELD CONTROL AND
PLACEMENT DATA

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

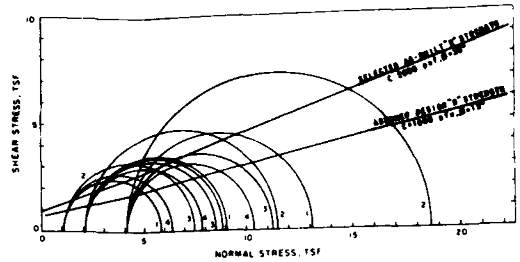
PLATE 30

2



GRADATION CURVES (RANDOM AND ABUTMENT INFILL)

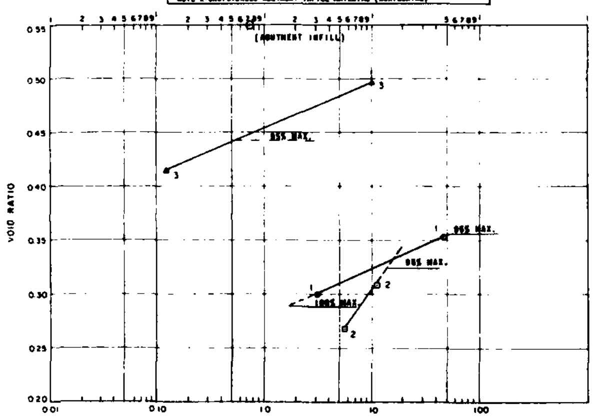
NO.	DIVISION SAMPLE NO.	SOIL CLASS SYMBOL	TYPE OF SAMPLE	PROPERTIES: INITIAL DRY DENSITY (PCF)	INITIAL MOISTURE CONTENT (%)	INITIAL SATURATION (%)	BEFORE SHEAR DRY DENSITY (PCF)	BEFORE SHEAR MOISTURE CONTENT (%)	BEFORE SHEAR SATURATION (%)
1	76790	SC-SM	REMOLDED	121.0-[illegible]	5.5-6.6	[illegible]	[illegible]	10.0 10.5	[illegible]
2	77905	SC-SM	REMOLDED	[illegible]	5.2-5.9	[illegible]	131.2 131.6	10.8-11.1	[illegible]
3	77906	SC-SM	REMOLDED	[illegible]	7.4-7.9	[illegible]	[illegible]	11.1 12.1	[illegible]
4	78681	SM	REMOLDED	116.5	5.5	[illegible]	[illegible]	[illegible]	[illegible]



"R" SHEAR STRENGTH (RANDOM)

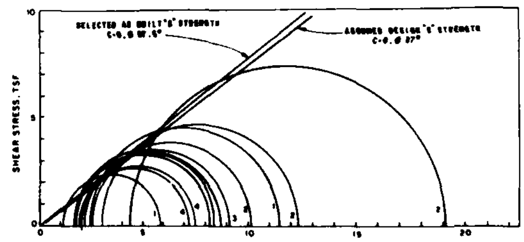
NO.	DIVISION SAMPLE NO.	MECHANICAL ANALYSIS 4	MECHANICAL ANALYSIS SAND	MECHANICAL ANALYSIS 200	SAMPLE DIAMETER (IN)	SAMPLE HEIGHT (IN)	REMARKS
1	76790	[illegible]	57	2	6.0	[illegible]	NOTE 1
2	77905	[illegible]	37	6	6.0	[illegible]	NOTE 1
3	78681	[illegible]	97	12	6.0	[illegible]	NOTE 1
4	74776	6	64	30	5.0	2.56	NOTE 2

NOTE 1: REMOLDED AT OPTIMUM MOISTURE CONTENT
NOTE 2: UNDISTURBED ABUTMENT INFILL MATERIAL (HORIZONTAL)



PERMEABILITY TEST DATA (RANDOM AND ABUTMENT INFILL)

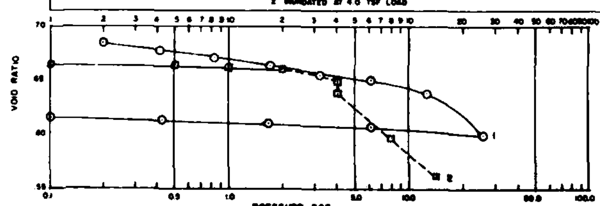
NO.	DIVISION SAMPLE NO.	TOTAL NORMAL STRESS (TSF)	EFFECTIVE NORMAL STRESS (TSF)
1	76790	1.0,2.0,4.0	[illegible]
2	77905	1.0,2.0,4.0	[illegible]
3	77906	1.0,2.0,4.0	[illegible]
4	78681	1.0,2.0,4.0	[illegible]



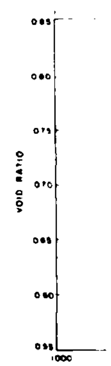
"S" SHEAR STRENGTH (RANDOM)

NO	SOIL CLASS SYMBOL	TYPE OF SAMPLE	PROPERTIES: BEFORE TEST DRY DENSITY (PCF)	BEFORE TEST MOISTURE CONTENT (%)	BEFORE TEST VOID RATIO	BEFORE TEST SATURATION (%)	AFTER TEST MOISTURE CONTENT (%)	AFTER TEST VOID RATIO	AFTER TEST SATURATION (%)	REMARKS
1	SM	UNDISTURBED	99.6	6.4	0.687	24	25	0.629	100	NOTE 1
2	SM	UNDISTURBED	94.7	6.7	0.666	26	22	0.563	100	NOTE 2

NOTES 1. SATURATED AT 3.20 TSF LOAD
2. SATURATED AT 4.0 TSF LOAD

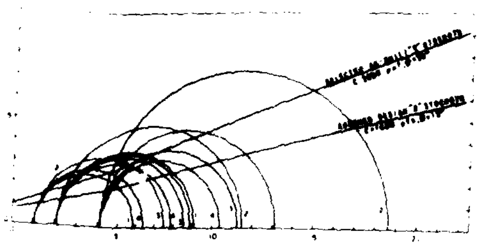


CONSOLIDATION TEST DATA (ABUTMENT INFILL)

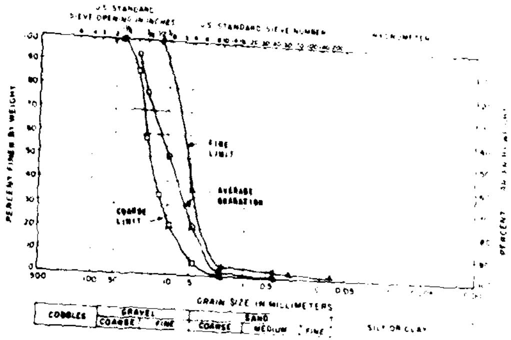


VALUE ENGINEERING PAYS

NO.	[illegible] SAMPLE NO.	[illegible]	[illegible]	PROPERTIES: INITIAL [illegible]	INITIAL [illegible] (%)	[illegible] (%)	BEFORE SHEAR [illegible] (PCF)	BEFORE SHEAR [illegible] (%)	[illegible] (%)
1	[illegible]	GC [illegible]	[illegible]	[illegible]	5.5 5.5	[illegible]	[illegible]	[illegible]	[illegible]
2	77906	GC [illegible]	[illegible]	[illegible]	6.2 6.4	[illegible]	[illegible]	[illegible]	[illegible]
3	77906	GC [illegible]	[illegible]	[illegible]	7.0 7.0	[illegible]	[illegible]	[illegible]	[illegible]
4	[illegible]	[illegible]	[illegible]	[illegible]	6.5	[illegible]	[illegible]	[illegible]	[illegible]

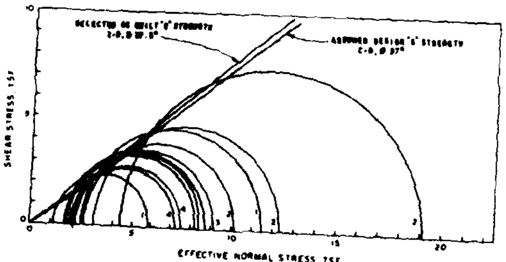


"R" SHEAR STRENGTH (RANDOM)



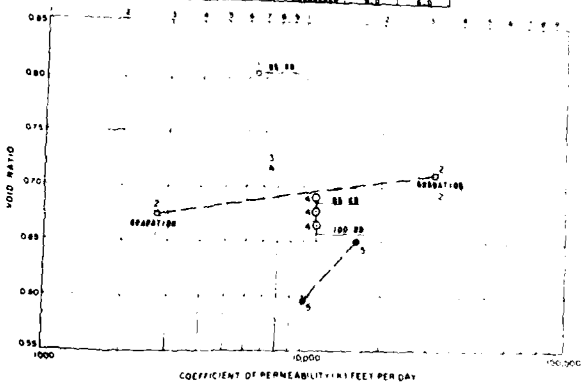
GRADATION CURVES (GRAVEL DRAIN)

NO.	[illegible] SAMPLE NO.	TOTAL NORMAL STRESS (TSF)	EFFECTIVE NORMAL STRESS (TSF)
1	[illegible]	1.0, 2.0, 4.0	[illegible]
2	[illegible]	1.0, 2.0, 4.0	[illegible]
3	[illegible]	1.0, 2.0, 4.0	[illegible]
4	[illegible]	1.0, 2.0, 4.0	[illegible]



"S" SHEAR STRENGTH (RANDOM)

NO	DIVISION SAMPLE NO	MAX PARTICAL (IN)	TYPE OF SAMPLE	DIAMETER	HEIGHT (IN)
1	76382	1	REMOLDED	6.0	6.0
2	77907	1½	REMOLDED	6.0	6.0
3	77906	1½	REMOLDED	6.0	6.0
4	76583	1	REMOLDED	6.0	6.0
5	[illegible]	[illegible]	REMOLDED	6.0	6.0



PERMEABILITY TEST DATA (GRAVEL DRAIN)

SYMBOL	DESCRIPTION	DATE	APPROVAL

REVISIONS

U.S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS

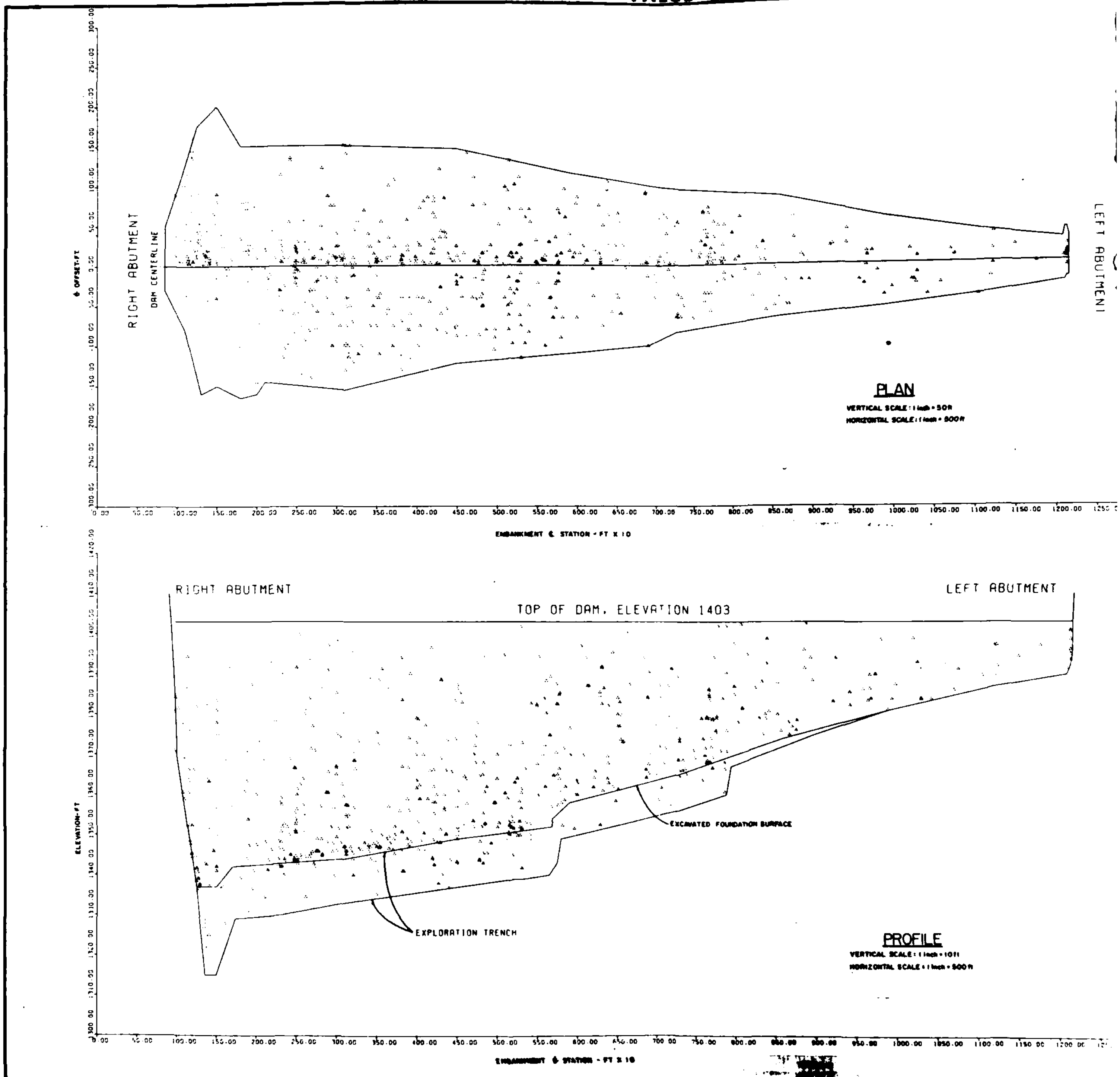
ADOBE DAM
RANDOM, GRAVEL DRAIN AND
ABUTMENT INFILL MATERIAL
RECORD TEST RESULTS

SUBMITTED BY: | DATE APPROVED: | SPEC NO. DACW09 | SHEET
DISTRICT FILE NO.

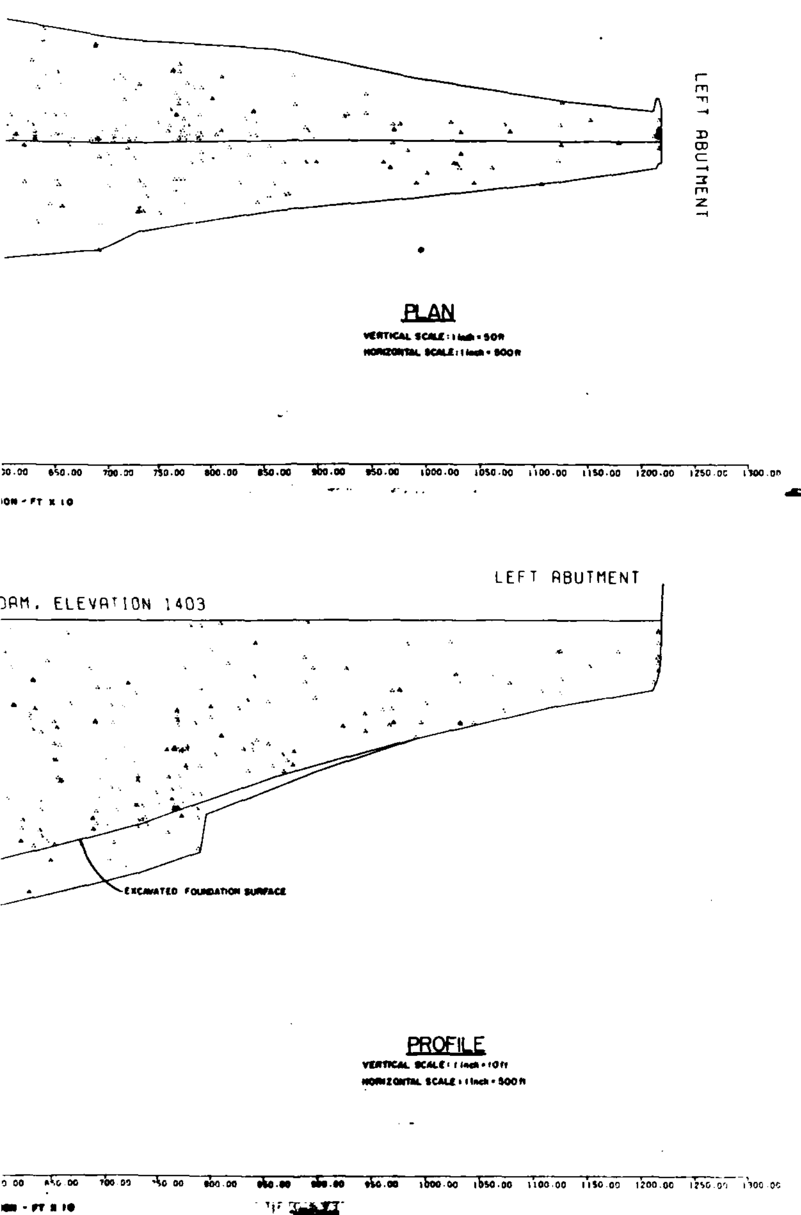
SAFETY PAYS

PLATE 31

VALUE ENGINEERING PAYS



SAFETY [illegible]YS



LEGEND
▲ LOCATION OF FIELD CONTROL TESTS

SCALE
1 inch = 10 ft — 0 10 20 ft
1 inch = 50 ft — 0 50 100 ft
1 inch = 500 ft — 0 500 1000 ft

SYMBOL	DESCRIPTION	DATE	APPROVAL

REVISIONS

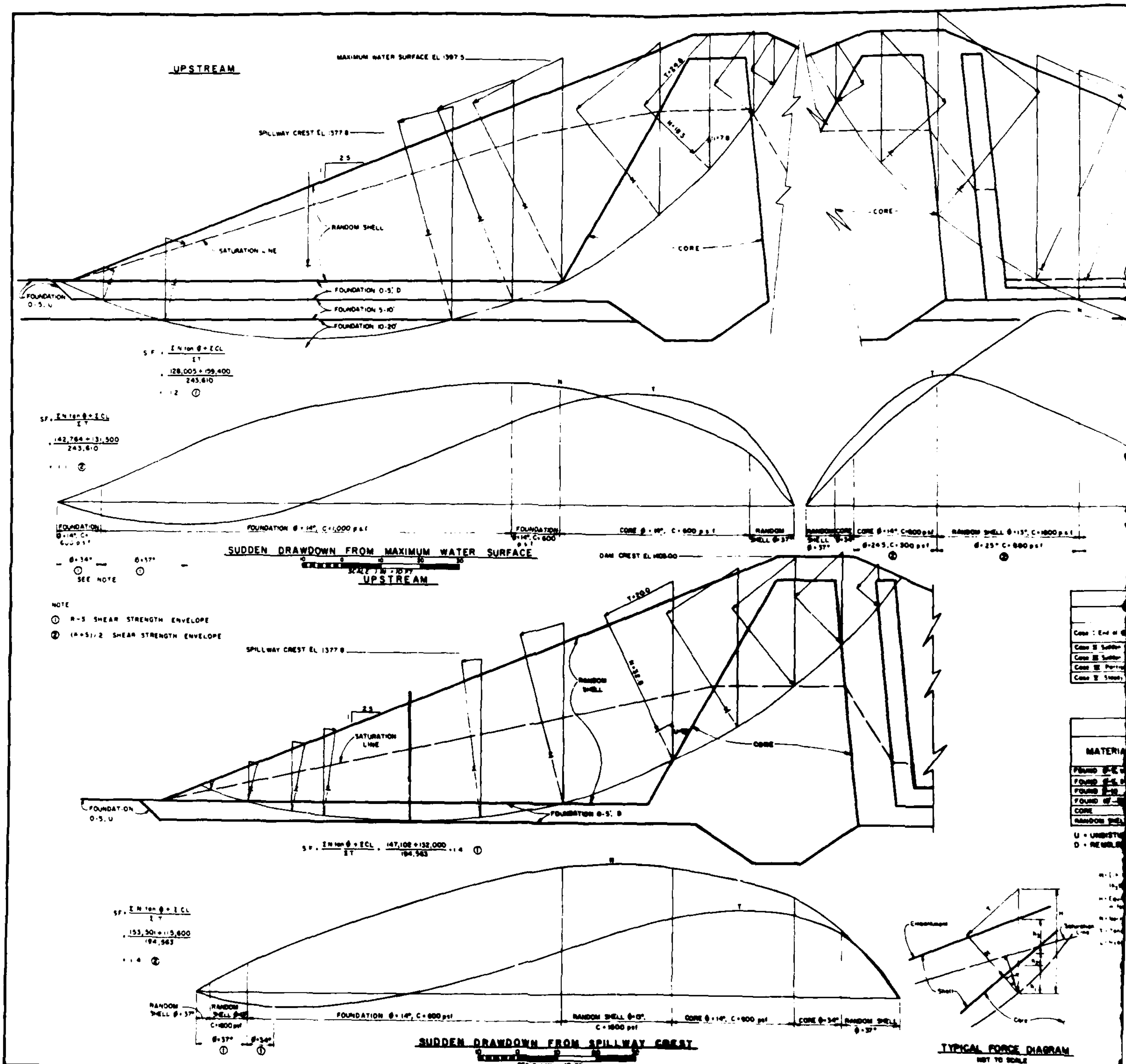
U. S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

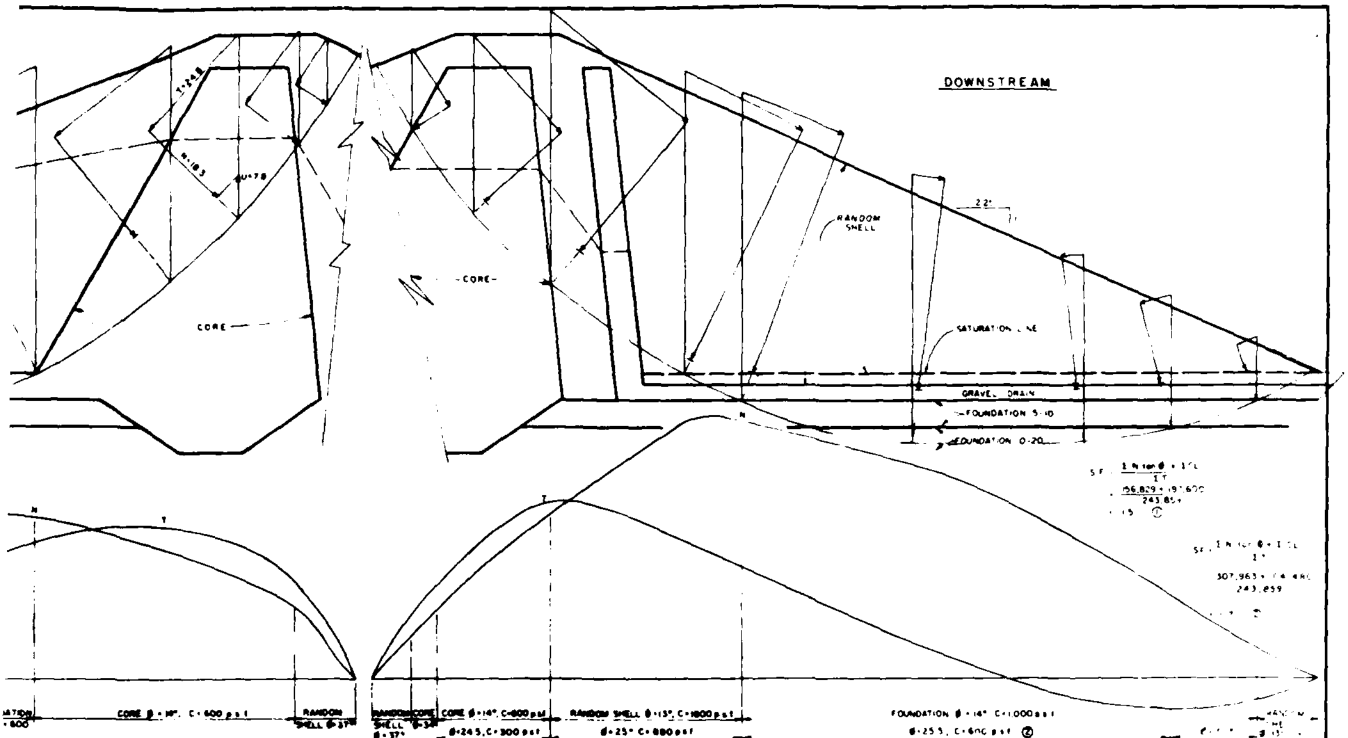
GILA RIVER BASIN, NEW RIVER AND
PHOENIX CITY STREAMS
ADOBE DAM
PLAN AND PROFILE OF
FIELD CONTROL TEST LOCATIONS
RANDOM AND CORE

DESIGNED BY: DRAWN BY: CHECKED BY: SUBMITTED BY: DATE APPROVED:
SPEC. NO. DACW09-____ B-____
DISTRICT FILE NO.
SHEET

PLATE 32

2


UPSTREAM
MAXIMUM WATER SURFACE EL 1397.5
SPILLWAY CREST EL 1377.8
RANDOM SHELL
SATURATION LINE
CORE
FOUNDATION 0-5' U
FOUNDATION 0-5' D
FOUNDATION 5-10'
FOUNDATION 10-20'
SUDDEN DRAWDOWN FROM MAXIMUM WATER SURFACE
DAM CREST EL 1405.00
UPSTREAM
NOTE
① R-S SHEAR STRENGTH ENVELOPE
② (R+S)/2 SHEAR STRENGTH ENVELOPE
SPILLWAY CREST EL 1377.8
SATURATION LINE
RANDOM SHELL
CORE
FOUNDATION 0-5' D
SUDDEN DRAWDOWN FROM SPILLWAY CREST
TYPICAL FORCE DIAGRAM
NOT TO SCALE



STEADY SEEPAGE

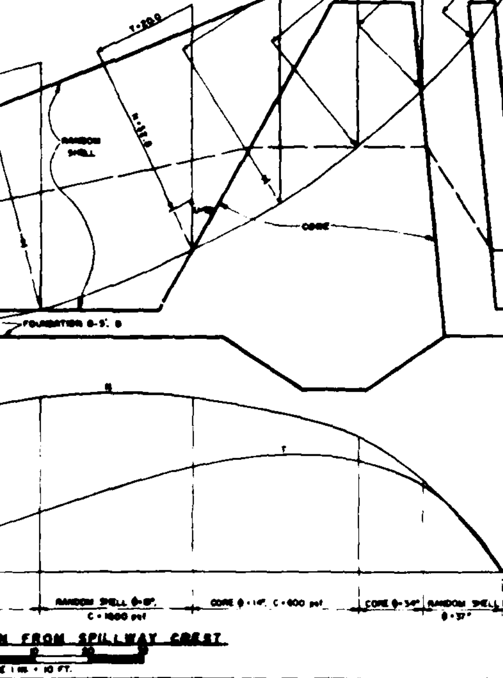
SCALE 1 IN = 10 FT

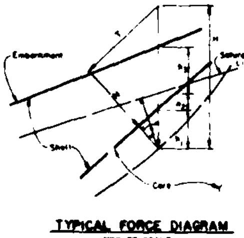
TABLE OF CALCULATED SAFETY FACTORS					
		Safety Factor	Min Allowable	Earthquake Safety Factor	Earthquake Min Allowance
Case I End of Construction	Upstream Slope	1.9	1.4	1.4	C
	Downstream Slope	2.0	1.4	1.5	[illegible]
Case II Sudden Drawdown - Max Pool		1.2	1.0	—	—
Case III Sudden Drawdown - Spillway Crest		1.4	1.2	—	—
Case IV Partial Pool		1.5	1.5	1.2	C
Case V Steady Seepage		1.5	1.5	1.3	1.C

TABLE OF ADOPTED DESIGN VALUES								
MATERIAL	SHEAR STRENGTH Q		R		S		UNIT WT	
	C-PSF	ϕ	C-PSF	ϕ	C-PSF	ϕ	γ M	γ SAT
FOUND 0'-5', U	6400	18°	300	10°	—	—	108	119
FOUND 0'-5', D	1200	30°	600	14°	—	—	121	130
FOUND 5'-10'	—	—	1000	14°	—	37°	125	134
FOUND 10'-20'	—	—	1000	14°	—	37°	118	126
CORE	—	30°	600	14°	—	34°	121	130
RANDOM SHELL	—	—	1800	13°	—	37°	132	145

U = UNDISTURBED
D = REMOLDED

γ M = DRAINED
γ SAT = SATURATED





TYPICAL FORCE DIAGRAM

NOT TO SCALE

N = Normal Force
T = Tangential Force

SYMBOL	DESCRIPTIONS	DATE	APPROVAL
REVISIONS			

U.S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA

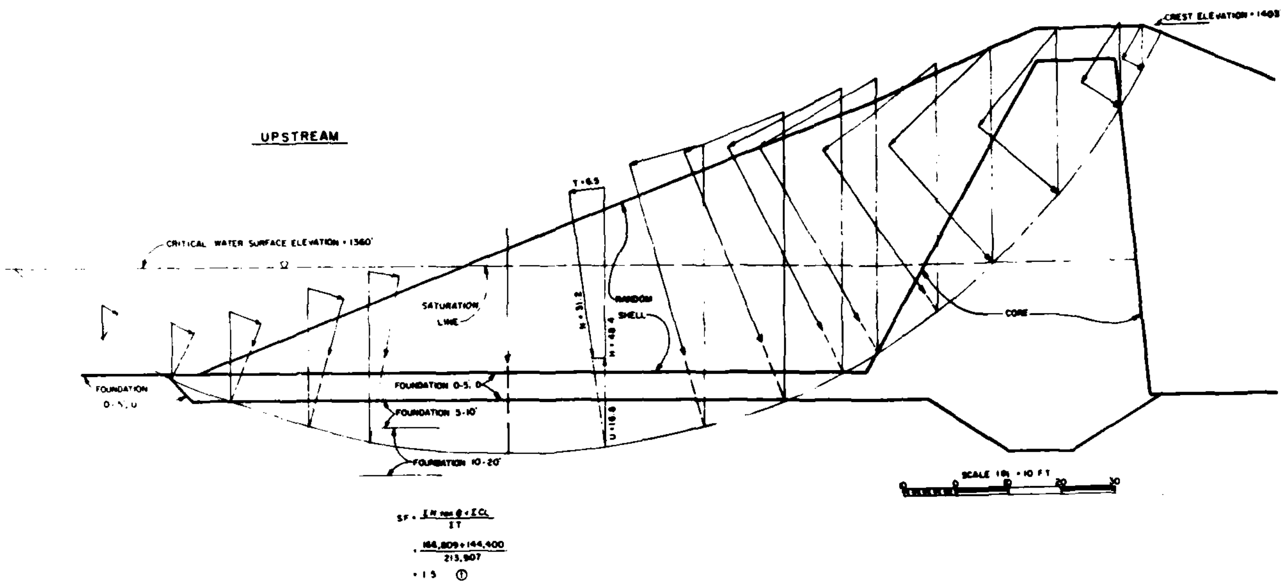
ADOBE DAM

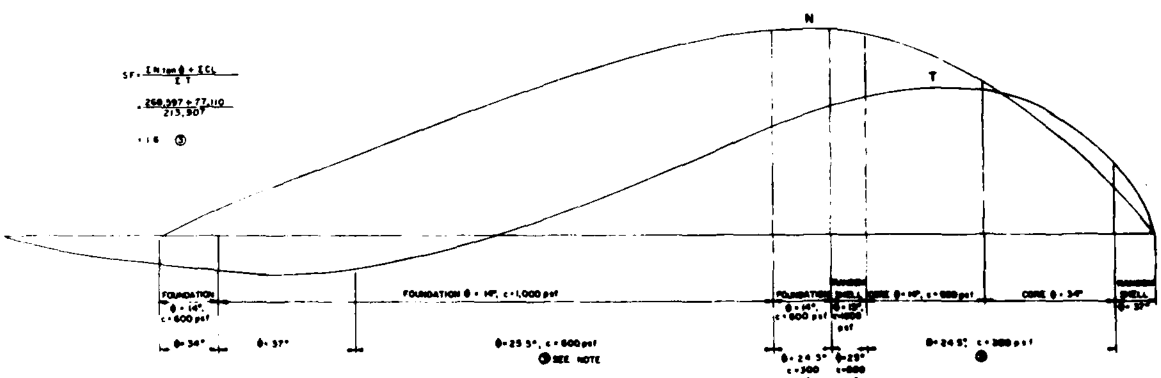
EMBANKMENT

STABILITY ANALYSES

DESIGNED BY: TLM
DRAWN BY: J.W.
CHECKED BY: TLM

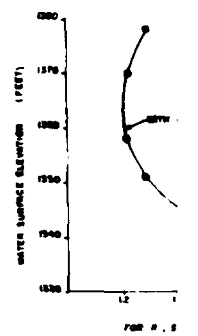
PLATE 33

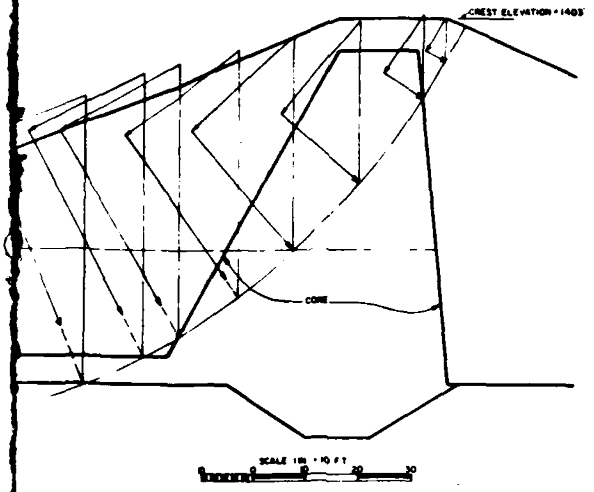


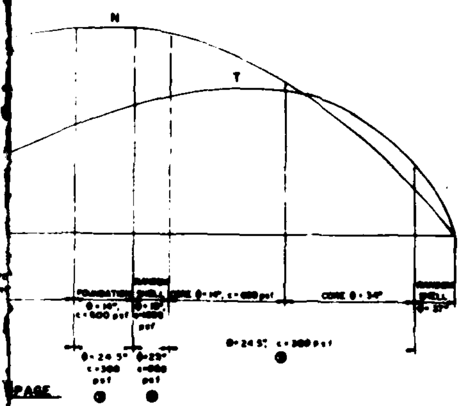


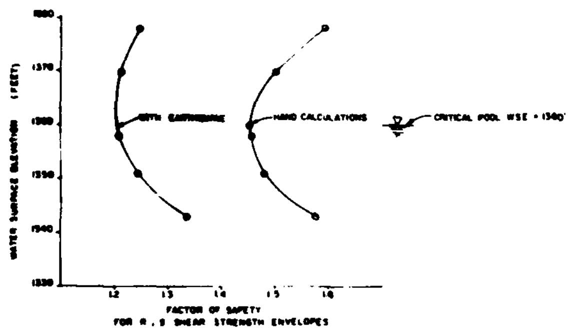
PARTIAL POOL WITH STEADY SEEPAGE

SCALE 1 IN. = 10 FT









NOTE

1. R-S SHEAR STRENGTH ENVELOPE
2. SEE PLATE 28 FOR ADOPTED DESIGN VALUES AND TYPICAL FORCE DIAGRAM
3. LOWER c & Φ VALUES ARE (R+S)/2 SHEAR STRENGTH ENVELOPES

REVISIONS

U.S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA

ADOBE DAM

STABILITY ANALYSIS

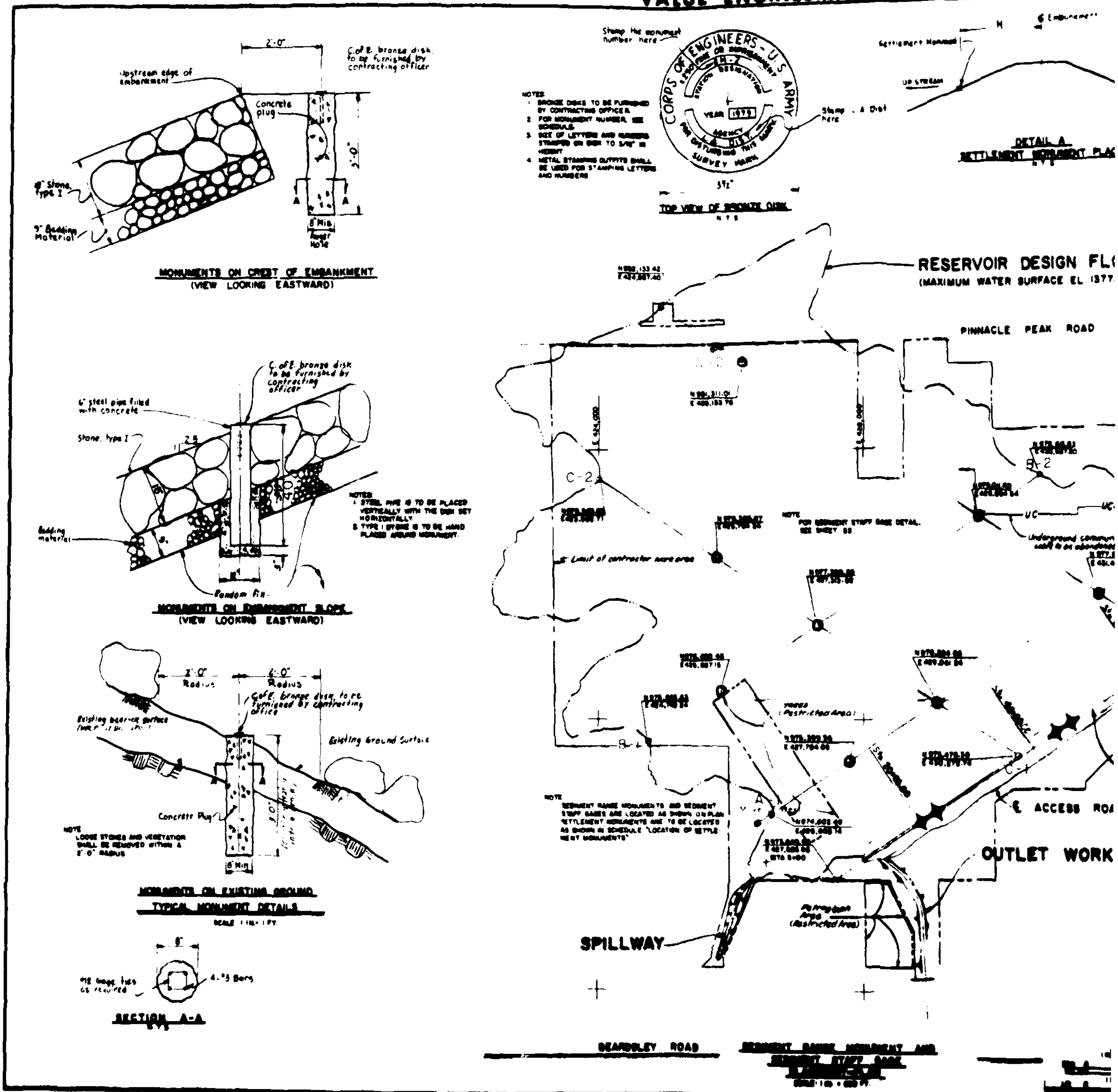
PARTIAL POOL CONDITION

J.W.

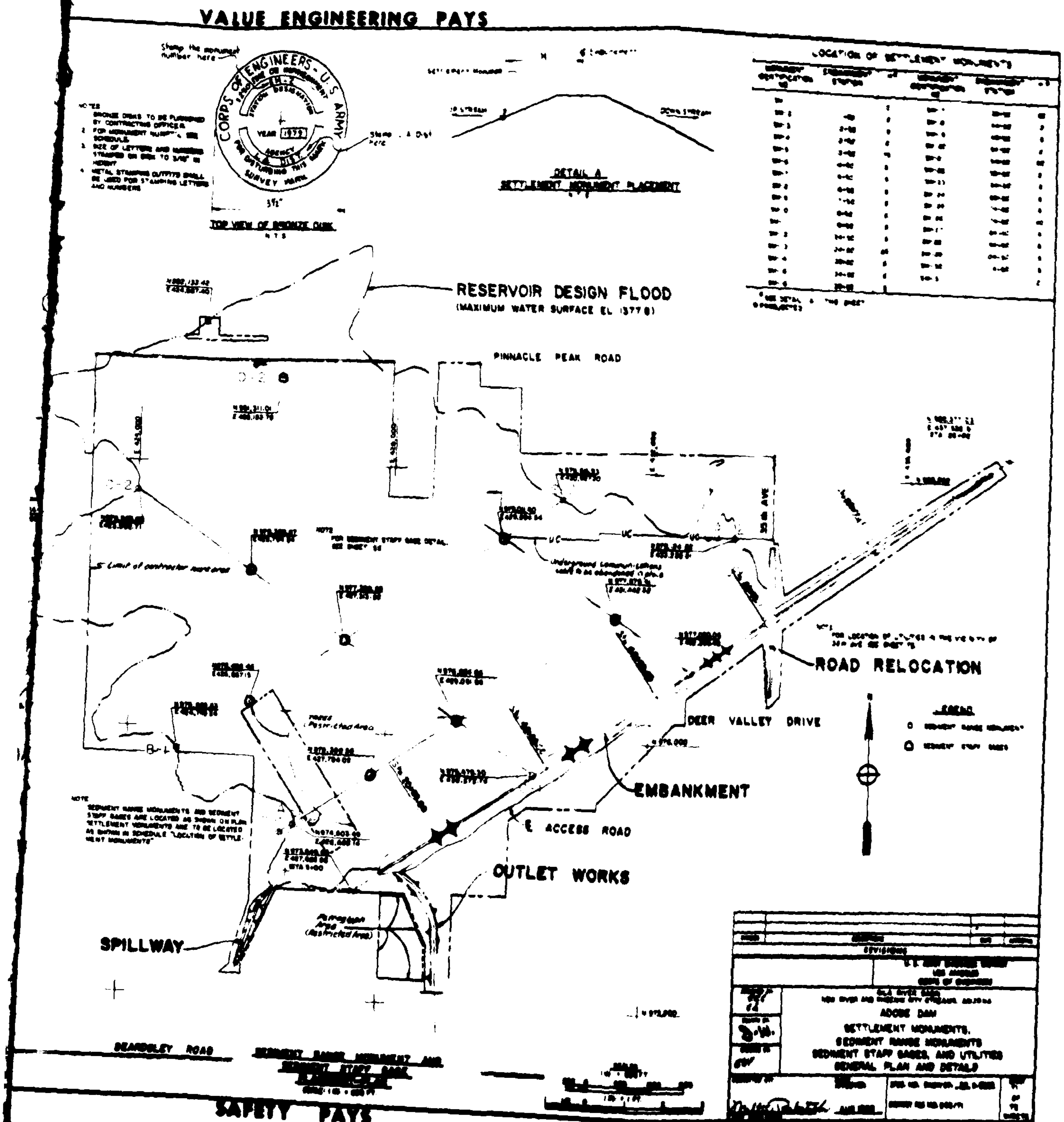
2

PLATE [illegible]

VALUE ENGINEERING PAYS



SAFETY PAYS



VALUE ENGINEERING PAYS
CORPS OF ENGINEERS - U.S. ARMY
YEAR 1979
SURVEY MARK
TOP VIEW OF BRONZE DISK
DETAIL A
SETTLEMENT MONUMENT PLACEMENT
RESERVOIR DESIGN FLOOD
(MAXIMUM WATER SURFACE EL 1377.8)
PINNACLE PEAK ROAD
35th AVE
ROAD RELOCATION
DEER VALLEY DRIVE
EMBANKMENT
ACCESS ROAD
OUTLET WORKS
SPILLWAY
LEGEND
BEARDSLEY ROAD
ADOBE DAM
SETTLEMENT MONUMENTS,
SEDIMENT RANGE MONUMENTS
SEDIMENT STAFF GAGES, AND UTILITIES
GENERAL PLAN AND DETAILS
SAFETY PAYS

PLATE 35

END

DATE FILMED

8-86